Final report

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October 22, 1984

SITE SELECTION PROCESS

PHASE 3B: SELECTION OF CANDIDATE SITES

Atmospheric Conditions

for

ONTARIO WASTE MANAGEMENT CORPORATION

2 Bloor Street West
11th Floor
Toronto, Ontario M4W 3E2

S.C. Barton
C.J. Baynes
N.D. Johnson
M. Dobson

Ontario Research Foundation

ONTARIO RESEARCH FOUNDATION

SHERIDAN PARK RESEARCH COMMUNITY
MISSISSAUGA, ONTARIO, CANADA L5K 1B3 • (416) 822-4111 • TELEX 06-982311

October 22, 1984

Mr. B.D. Mitchell
Director, Corporate Planning
and Development
Ontario Waste Management Corp.
2 Bloor Street West
11th Floor
Toronto, Ontario
M4W 3E2

Dear Mr. Mitchell,

RE: Phase 3B Report

We are pleased to submit our final report on Phase 3B of the OWMC project entitled, "Site Selection Process Phase 3B: Selection of Candidate Sites". The report documents the work activities undertaken during this phase of the program, including our results and conclusions relative to air quality and meteorological aspects of the initial comparative evaluation of candidate sites.

We appreciate the opportunity to have undertaken this work for you.

Sincerely,

S.C. Barton
Assistant Director
Environmental and Chemical
Engineering Division

SCB/sj

cc: D.W. Heeney

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PREFACE

This report is concerned with the air quality aspects of selecting a site for the Ontario Waste Management Corporation's hazardous waste management facilities. Previous work by OWMC [OWMC, 1983(a)] has identified the Golden Horseshoe (Oshawa to Niagara Falls area) as the region of the Province where the search for a site should be centered. OWMC identified candidate areas within this region on the basis of certain constraints [OWMC, 1983(b)], including atmospheric dispersion. It is within these candidate areas that sites are currently under consideration. In an earlier report information was provided on areas of high pollution potential within Southern Ontario considering climatology, meteorology and topographic features (Barton and Dobson, 1982). This study resulted in the exclusion of land adjacent to the Great Lakes shorelines, regions bordered by the Niagara Escarpment, and major urban centres. Further details on the basis of these constraints were given in a more recent report (Barton and Dobson, 1983) together with a corresponding constraint map for the Golden Horseshoe region.

The present report forms part of the Phase 3 site selection process and is divided into two parts. Part 1 provides an evaluation of existing air quality across the candidate areas, based on monitoring data, mathematical dispersion modelling and a review of the literature. Spatial trends for four criteria pollutants (sulphur dioxide, nitrogen oxides, suspended particulate matter and hydrocarbons) are given as indicators of relative degradation of existing air quality among the different candidate areas.

Part 2 deals with the evaluation of the potential sites specified by OWMC. It, in turn, is divided into two major sections, first describing the initial qualitative assessment and ranking of potential sites from the standpoint of air pollution potential, and then outlining the methodology to be followed in the more detailed assessment of candidate sites in Phase 4 of the OWMC site selection process.

EXECUTIVE SUMMARY

PURPOSE OF THE REPORT

The main purpose of this report is to consolidate available information on meteorology, climatology, topography, atmospheric emissions and ambient air quality relevant to the OWMC candidate areas to provide input to the comparative evaluation of potential sites.

The second purpose of the report is to provide a preliminary evaluation of potential sites, based on air quality considerations using, in part, the air quality information contained herein. Thirdly, the report provides a framework for the further detailed evaluation of candidate sites.

SCOPE AND METHOD

In the identification of candidate areas in earlier Phase 3 work, ORF identified areas in the Golden Horseshoe region which, due to their geographical location, would be expected to experience relatively poor conditions of atmospheric dispersion and, therefore, relatively frequent episodes of high air pollution. Accordingly, these areas were excluded from consideration in the selection of OWMC candidate areas. Due to the scale at which air quality phenomena occur, and the spatial resolution of the important variables available from existing data, it was not considered necessary or feasible to include additional atmospheric considerations at the constraint mapping stage (leading to the selection

of site areas from within the candidate areas) nor in the site screening process (selection of potential sites from within the site areas). However, the more detailed process of comparative evaluation of potential sites and candidate sites requires that any significant variation in existing air quality within the candidate areas be identified and an inventory of other pertinent information on local topography, climatology, meteorology and atmospheric emissions be gathered so that any differences in these factors between sites can be considered. The study of existing air quality is important in determining the capacity of the atmosphere to accept additional emissions without exceeding established standards or criteria. The other factors contribute to the assessment of existing air quality and are used to determine the relative potential impacts of an OWMC facility at each site.

The study of existing air quality across the candidate areas was accomplished, primarily, using mathematical modelling techniques. While a large number of air quality monitoring stations exist in the Golden Horseshoe region, mainly in urban areas, the general lack of spatial definition in the predominantly rural areas of interest here necessitated the use of dispersion modelling. The model provided estimates of the spatial patterns in air quality due to man-made emission sources within the region. The "background" due to natural sources and transport into the region from distant sources was not modelled. In general, this background can be considered constant across the candidate areas.

The input data assembled for the dispersion modelling consisted of:

- o emission information (including all source information for both point and area sources from Toronto to Hamilton, and from Niagara to Nanticoke). Point sources, treated separately in the analysis, were defined as those with an average emission rate of 0.6 grams per second (g/s) or

greater of each contaminant considered, and/or a stack height of 18 m or more. All other sources were grouped together as area sources.

- o detailed topographic information, as well as representative climatological and meteorological parameters (i.e., winds, atmospheric stabilities, mixing heights, etc.).

The model output required at this stage was only intended to indicate general spatial patterns in air quality. Therefore, contour maps of annual average concentrations of four common air pollutants were produced to represent these patterns. The four pollutants were sulphur dioxide, nitrogen oxides, total suspended particulate and total hydrocarbons. Contours were drawn through the candidate areas and 5 km beyond the boundaries of these areas. In addition, the most recent ambient air quality data from monitoring stations in and around the candidate areas were assembled and used to validate the results of the mathematical modelling. Resulting concentrations for each candidate area were compared to determine those areas presently experiencing relatively high pollutant levels.

A wider range of pollutants, other than the four mentioned above, could be potentially emitted from the OWMC facility. These include trace organics, trace metals, macroelements, nutrients and acid gases, which are not routinely monitored in ambient air. Furthermore, the emissions inventory necessary for successful mathematical modelling of the existing levels is also not available. Nevertheless, in order to characterize the air quality levels which might be expected in Southern Ontario, and to provide information for later evaluations of potential impacts of the OWMC facility, a literature search was conducted and tables compiled of the typical concentrations of these other pollutants in general urban and rural environments.

The preliminary evaluation of potential sites was carried out on the basis of drive-through inspections and an assessment of air quality factors at each site, including existing air quality, as estimated by the present report. This information was consolidated with the results of evaluations undertaken by other consultants (Ecologistics, 1984, IER, 1984) to enable an overall evaluation of each site to be made (M.M. Dillon, 1984).

A methodology for Phase 4 evaluations of candidate sites using results of the present study, in conjunction with local dispersion modelling and other facility and site specific information, was outlined. Since facility size and process details will not have been fixed, the methodology relies primarily on the quantitative assessment of local atmospheric dispersion conditions and receptor characteristics. A relative population exposure index and sensitive crop and livestock impact indices would be calculated for each site assuming unit emissions of an unspecified pollutant. Thus, variations in site conditions would be reflected in the results, but no assumptions would be necessary concerning the composition and quantity of the emissions. However, it is expected that preliminary estimates of emissions from the OWMC facility will also permit at least preliminary assessments to be made in more absolute terms, i.e., by predicting contaminant concentrations due to incinerator stack emissions and comparing these to existing levels and to air quality standards and criteria.

PREMISES AND POSTULATES

This study was based on two fundamental premises:

- the study was restricted to the candidate areas, as previously selected by OWMC and considered as being potential areas for siting an incineration facility.

- o the focus of the study is the potential emissions from an incinerator stack.

In addition, a number of assumptions, or postulates, were necessary during both the design and execution of the study:

- o it was decided that it was feasible to model ambient concentrations of four common air pollutants, for which detailed emission information is available for most of the Golden Horseshoe region. Emission data are not available for other atmospheric constituents, such as trace metals and acid gases, which are also potential incinerator emissions. However, it is assumed that the levels predicted for these four "criteria" pollutants will provide a relative indication of the general patterns of pollutant levels to be expected across the candidate areas.

- o in the emissions inventory input to the dispersion model, sources were grouped into two categories; point and area sources. Point sources were taken to be from relatively large industrial or commercial facilities with an average emission rate of each contaminant considered of 0.6 g/s or greater, and/or a stack height of 18 m or more.

- o the dispersion modelling was designed to provide estimates of existing air quality throughout the candidate areas, as well as an influence area extending 5 km beyond the boundaries of the candidate areas. This would include areas expected to experience the greatest air quality impact, should an incineration facility with a stack height of about 100 m or less be located at or close to the edge of a candidate area.

- o it was not considered feasible to attempt predictions of patterns in background air quality over the life of the OWMC facility, i.e. future patterns of air quality which would prevail if the OWMC facility were not built. However, the estimates of existing air quality provided by the dispersion modelling indicate general patterns of air quality across the Golden Horseshoe region and these are expected to prevail in the foreseeable future.

STATUS OF DATA

The types of data gathered and the major sources of information are listed below:

- o topographic (drive through, topographic maps).
- o meteorological and climatological (Atmospheric Environment Service).
- o emissions (Ontario Ministry of the Environment).
- o air quality (Ontario Ministry of the Environment, Nanticoke Environmental Monitoring Programme, Ontario Hydro and other published literature).

Topography was considered in a very general sense only, i.e., with respect to impeding dispersion within candidate areas; more detailed considerations will form part of future site-specific studies. Meteorological and climatological data from four stations (St. Catharines, Toronto, Mount Hope and Buffalo, New York) were used to represent all of the candidate areas. This is the best resolution available, but some

minor inaccuracies may be introduced when representing the local conditions at some candidate areas.

Some data gaps were apparent in the Ontario Ministry's emissions inventory, and data had to be extrapolated from other areas to fill the gaps in the grid. Furthermore, smaller sources (less than 0.6 g/s) were lumped together as area sources. At the fringes of the study area, in the west end of Toronto and the New York side of the Niagara River, there were major omissions in the inventory. As well, it should be noted that emission data are subject to a certain amount of estimation error, although only data which have been validated and approved by the Ministry have been used.

Results from the mathematical dispersion modelling are subject to some uncertainty due to the inaccuracies of the input climatological data and emissions inventory, and to the inaccuracies inherent in all dispersion models. However, actual measurements of air quality in the study area provided direct validation of the modelling results. The good agreement found between modelled and measured values, after all relevant factors had been accounted for, permits the estimated pollutant concentrations to be used with considerable confidence.

MAIN FINDINGS

The major findings of this study are listed below:

- Ambient air quality measurements throughout the region in the past few years indicate that air quality in the candidate areas generally is in compliance with provincial criteria. Occasional short-term exceedances were recorded for sulphur dioxide, ozone, total reduced sulphur and total suspended particulates, but can generally be accounted for by specific local sources or long-range transport of

pollutants into the region. Selected trace contaminants such as nickel, lead and fluorides, which have been monitored in the study area to a limited degree, have exceeded air quality criteria on occasion.

- The dispersion modelling predicted air quality levels and spatial patterns attributable to man-made sources within the study region (see the contour maps incorporated in this report i.e., Figures 3, 4, 5 and 6). The levels are in good general agreement with monitoring results and the patterns are consistent with the known distribution of emission sources.

- The air quality levels output by the model are all well below applicable criteria. However, the highest relative loadings were found in those candidate areas closest to Niagara Falls and Brampton. The lowest concentrations were found near Milton and at the west end of the Niagara peninsula, northeast of Simcoe.

- Background levels and natural sources of suspended particulate matter and hydrocarbons can potentially account for as much as 35% to 47% and 80%, respectively, of measured ambient levels. The addition of these increments to the modelled values results in good agreement with measured values.

- In the preliminary evaluations of potential sites, fourteen potential sites were assessed with respect to existing air quality, surrounding topography, population density around the site, and other relevant factors. The evaluations were grouped into four categories of potential constraint: "no", "minor", "moderate" and "major", and the definitions of

these categories are described in Section 5.3 (page 44). Three sites had no constraints, three had minor potential constraints, seven were considered to have moderate potential constraints, and one to have major potential constraints. (For the purposes of the preliminary evaluation, these rankings were relative only. The constraints identified were not considered sufficient in themselves to reject a candidate site).

CONCLUSIONS AND RECOMMENDATIONS

The major conclusions and recommendations resulting from this study are:

- The levels of air pollutants, in terms of the annual average concentrations of criteria pollutants, in and near the candidate areas are well below applicable criteria. On this basis, it is considered that air quality throughout the study area is generally satisfactory and, at this stage, it is recommended that no sites be excluded on the grounds of existing air quality.

- Short term exceedances of criteria recorded at some monitoring stations can be attributed to specific local sources of air pollution or to long-range transport. These cases should be considered during the detailed assessment of candidate sites. Such site-specific studies should include measurement of criteria pollutants and many of the trace contaminants which may be emitted from the OWMC facility, in order to properly characterize the existing local air environment.

- A preliminary evaluation provided a relative ranking of the fourteen potential incinerator sites into four categories.

While the results provide some guidance for the initial site selection activity, they should not be used by themselves to eliminate any site from consideration. It is recommended that a more rigorous and quantitative analysis of candidate sites be carried out at the Phase 4A site selection stage.

- A methodology is recommended which can be used in future candidate site evaluations, and which is a logical extension of the present work. Dispersion calculations would be carried out for unit emission of an unspecified contaminant at each candidate site. These would be combined with local data on sensitive vegetation and population distribution to provide a quantitative, relative ranking of sites. The expected contribution to absolute air pollution levels would also be estimated and compared to existing local air quality and applicable criteria.

PART 1

AIR QUALITY - CANDIDATE AREAS

1. INTRODUCTION

1.1 BACKGROUND

The most commonly considered and monitored air pollutants, often referred to as "criteria" pollutants, include sulphur dioxide (SO_2), total suspended particulate (TSP), nitrogen oxides (NO_x), hydrocarbons (HC), ozone (O_3) and carbon monoxide (CO). Many industrial processes and fuels contribute to SO_2 levels. Total suspended particulate matter arises from combustion sources, construction activities, industrial processes, transportation and agricultural activities. The main sources of nitrogen oxides include auto exhaust, power plants, incinerators and chemical processes. Hydrocarbons are emitted from vehicles, gasoline storage tanks, and various industrial processes. Ozone is a product of atmospheric photochemical reactions. High concentrations are found some distance from major sources due to transport of ozone and its precursors (hydrocarbons and nitrogen oxides), and subsequent reactions. Because of its dependence on various chemical mechanisms, ozone levels are highest during the warmer months, as conditions for formation are optimized at this time. Carbon monoxide originates primarily from mobile sources.

Standards and criteria have been established for these and some other pollutants with the objective of protecting human health and the natural environment. The absence of standards or criteria for other chemical compounds does not necessarily mean that any level of these materials is safe or acceptable. Rather, in many cases, it reflects the fact that not enough is known about the compound to permit standards to be established with any certainty.

Emissions of the above mentioned criteria pollutants from the proposed OWMC waste management facilities are expected to be relatively minor, especially when compared to other point sources in the Golden Horseshoe. Furthermore, it can be expected that both low and high molecular weight organic compounds will, for the most part, be efficiently destroyed by incineration. Aerosols that could be emitted are expected to contain traces of condensed high molecular weight species, as well as metallic oxides and salts depending on the types of wastes treated. Acid gases, such as HCl and HF, that can be produced during combustion of halogenated wastes, can also be removed efficiently and are thus expected to be released in only small amounts. In conjunction with efficient destruction and removal, waste blending can reduce emissions of any particular compound. Ground level concentrations of all pollutants are estimated to be well below regulated 1/2-hour point-of-impingement concentrations, confirming the general validity of these premises.

This part of the report is primarily concerned with the development of a data base and methodology that can be used as the basis of the air quality component of the Phase 3 site selection process. Topographical features, climatological data, emission inventory data, and air quality monitoring results for the criteria pollutants were the principal inputs to this study of the candidate areas. This information was supplemented by dispersion modelling in order to define air quality between the widely spaced monitoring stations, and to derive conclusions regarding the distribution of pollutants likely to be of concern when siting and assessing the OWMC facility. As well, a review of published literature on existing levels of other trace contaminants likely to be emitted from the facility provides an overview of anticipated background levels of these pollutants.

1.2 SCOPE AND OBJECTIVES

The scope and objectives of this part of the present study can be summarized as follows:

(a) to consolidate information on topographic, meteorological, and climatological influences on the candidate areas and their immediate surroundings which is of relevance to air quality and atmospheric dispersion conditions.

(b) to summarize the available emission source data and ambient air quality data in the region.

(c) using (a) and (b) above and dispersion modelling, to determine relative air quality conditions in and around candidate areas as one basis for assessing the desirability of the potential sites for the OWMC facility.

1.3 INPUT DATA USED

Topographic information for this report has been drawn from previous reports for OWMC (Barton and Dobson, 1982 and 1983) and additional details of terrain elevations across the study area have been acquired from topographic maps. A drive-through inspection of the candidate areas has been conducted to assess any features likely to modify local air quality or atmospheric dispersion characteristics and all noted features relevant to the study have been incorporated into the data base.

Climatology data from previous reports (Barton and Dobson, 1982 and 1983) also have been used in this study, together with additional

statistical analyses of the occurrence of wind and atmospheric stability conditions at Toronto International Airport, Mount Hope Airport, and St. Catharines. Mixing heights for the region have been estimated from radiosonde data from Buffalo, New York.

The most recent air quality data available for the Golden Horseshoe area (Ontario Ministry of the Environment, 1983(b), Ontario Ministry of the Environment, 1981; and Ontario Hydro, 1983), have been assembled. The continuous monitoring data reported in terms of hourly, daily and annual averages are available for only a relatively limited range of air pollutants, i.e., total suspended particulate (TSP), sulphur dioxide (SO_2), nitrogen oxides (NO_x), hydrocarbons (HC), ozone (O_3) and carbon monoxide (CO). Information on other pollutants such as heavy metals, acid gases and trace organic constituents is less readily available, but has been summarized to the extent possible in this report. In addition, the literature has been surveyed with the objective of defining characteristic levels of other air contaminants which can be expected in urban or rural Southern Ontario.

An extensive emission source data base has been assembled using the Ministry of the Environment's inventory of area and point sources of pollutants for the candidate areas and their surroundings (Ontario Ministry of the Environment, 1983[a]). Again, information on the primary pollutants of TSP, SO_2, NO_x and HC are most readily available and have been used here. The area source data have been apportioned to 5 x 5 kilometre or 2 x 2 kilometre grids as shown in Figure 1 (overleaf). Major point sources with emission rates for each contaminant greater than 0.6 g/s and/or stacks higher than 18 m also have been identified within these gridded areas. Emission rates and input parameters for each source were defined in accordance with dispersion model input requirements. A total of approximately 420 sources were considered. Similarly, area source emission rates were defined for each of the grids indicated in Figure 1. Point sources were referenced to the closest grid corner. It should be noted that, although the relative density of emission sources

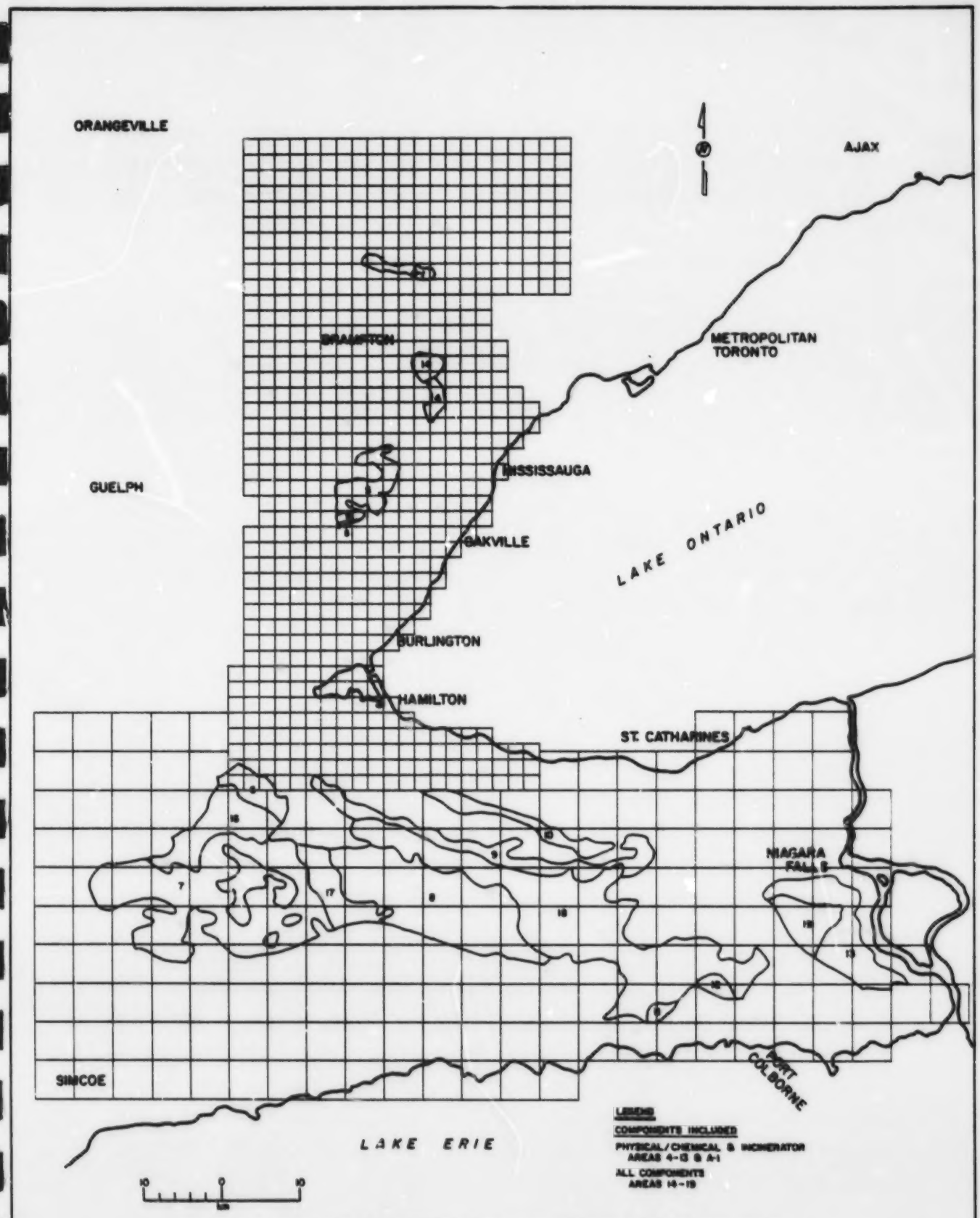

FIGURE 1 AREA SOURCE EMISSION DATA GRID SYSTEM USED IN THE MODEL.

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is an indicator of the potential for air quality degradation, the contribution of atmospheric dispersion to ambient air quality levels must be considered as an important factor. Therefore, emission data alone should not be used to judge air quality. Instead, monitoring data and/or dispersion modelling results should be used.

1.4 METHODOLOGY

The major analytical part of this study involved the estimation of spatial patterns in air quality across the study area. In view of the relative paucity of monitoring data, i.e., concentrated mostly in built-up urban areas, as well as the known variation in monitoring data due to local siting factors, it was considered desirable to supplement this information by a simulation of air quality across the area, based on dispersion modelling and the source emissions inventory.

The modelling was conducted using the U.S. Environmental Protection Agency's Industrial Source Complex (ISC) model, which provides annual average concentrations at any given receptor based on defined sources, local topography and climatological conditions. This allowed the preparation of isopleths, or contour lines, of concentrations of SO_2, NO_x, TSP and THC as indicators of relative air quality that can be expected to occur throughout the candidate areas. The available monitoring data also were evaluated along with the results of the modelling exercise in order to confirm local trends, especially around the more industrialized areas of Hamilton, Toronto and Niagara Falls. Literature information and specific survey data also were assessed in order to estimate the likely background of concentrations of other pollutants not monitored in the area. Data were provided with respect to individual chemical constituents within several general contaminant classes for which monitoring data could be found, and emphasis was placed on those pollutants which might occur in emissions from an industrial waste treatment facility.

2. AIR QUALITY DATA

2.1 INTRODUCTION

The existing air quality of an airshed is an important component to define in the process of siting any new facility. Pollutants such as SO_2, TSP, NO_x, HC, CO and O_3 are regularly monitored in several networks in or near the candidate areas. While it is anticipated that these pollutants will be emitted from the facility in rather insignificant amounts, these constituents are regulated by the Ontario Ministry of the Environment. Levels of these pollutants also can be used, on a relative basis, as indicators of overall air quality in candidate areas. In conjunction with routine monitoring of these common pollutants, increasing attention is being dedicated to the assessment of other trace constituents such as metals, organic compounds and acidic materials which may be toxic to humans or injurious to specific plant life or other receptors. Unfortunately, very little monitoring data presently exist for these constituents.

This section provides information that can be used to estimate pollutant levels that are likely to prevail in the candidate areas. Where possible, actual experimental measurements taken in or near the areas are used. In other instances, the results of a literature survey which provides a general overview of typical levels in urban, rural and remote areas is used to define the levels which can be expected to occur in the areas of interest. Some specific uses of these data are:

1. to define the generally prevailing air quality in the candidate areas relative to existing criteria and standards and, thus, identify any compounds or pollutant classes that may require specific pre-operational monitoring, as well as assessment and control during actual waste treatment operations.

2. to define prevailing air quality on a site-to-site basis for use in comparative site evaluations.

3. to place in perspective the contribution that potential emissions from the OWMC facility may make relative to existing levels.

2.2 MONITORING DATA - CRITERIA POLLUTANTS

Data from several monitoring networks were used to represent the ambient air quality in and around the candidate areas. The Ontario Ministry of the Environment operates numerous sites throughout Southern Ontario, 13 of which were felt to be representative of the candidate areas. Data from 16 Nanticoke Environmental Monitoring Programme (NEMP) stations were also included in the data provided by the Ministry, as well as 5 Ontario Hydro monitoring stations in the vicinity of the Lakeview Generating Station. The locations of the stations are shown in Figure 2 (overleaf). Several of the stations only monitored SO_2 or suspended particulate matter. However, the remaining stations also monitored for ambient NO_x, CO, O_3, and HC levels. As mentioned above, the patterns in air quality defined by these criteria pollutants can be used to indicate relative trends in other pollutants across the study areas.

Data for the years 1980, 1981 and 1982 have been used to estimate the pollutant levels presently occuring in the study areas. The three years

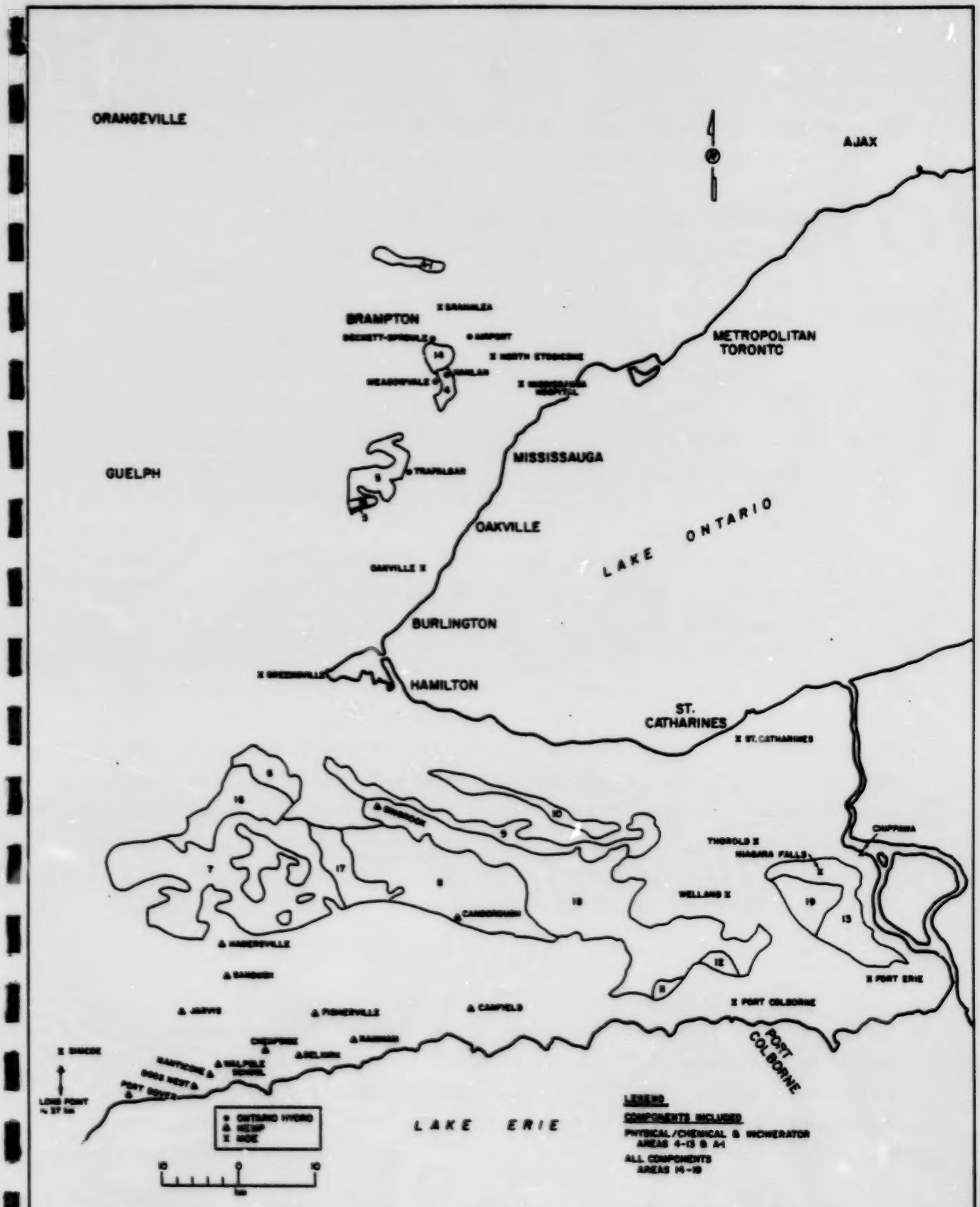

FIGURE 2 LOCATION OF AIR QUALITY STATIONS WITH RESPECT TO THE CANDIDATE AREAS.

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of data have been consolidated to provide a "mean", or representative definition of each pollutant at the various monitoring sites as follows:

- an overall annual average value has been calculated as the arithmetic mean of the three annual average values. The small variation from year-to-year permits this "mean" value to be used as an appropriate measure of long-term pollutant levels, including comparison, in at least qualitative terms, with the annual criterion,

- the frequency of occurrence of high values is indicated by summarizing the total numbers of values in excess of air quality criteria during the three year period considered,

- the range of observed values is indicated by citing the maximum values for each averaging period for which a criterion exists.

These data are presented in Tables A-1 to A-9 in Appendix A. In these tables the monitoring stations have been arranged alphabetically within two general study areas: namely, the Halton/Peel area and the Niagara Peninsula. As can be seen from Figure 2, the Halton/Peel study area includes candidate areas 4, 5, 14, 15 and A-1, and the Niagara Peninsula study area contains candidate areas 6-13 and 16-19, inclusive. Candidate areas 1, 2 and 3 were not included in the study, as these were previously determined to be unsuitable for an incinerator site (OWMC, 1983[b]).

2.2.1 HALTON/PEEL REGION

Sulphur dioxide levels for eight monitoring stations in this region are summarized in Table A-1. There were no annual or 24-hour criteria exceedances during 1980, 1981 and 1982. Several one-hour criterion exceedances were recorded at a number of the stations. Although these

exceedances are relatively infrequent, it is an indication of some significant impact by local point sources.

Total reduced sulphur (TRS) was measured at only the Oakville station in this region (see Table A-2). The one-hour criterion of $30ug/m^3$ for H_2S can be considered as an indicator of acceptable levels of TRS. There were 123 exceedances of the one-hour standard over the three year data base studied, reflecting the combined influence of a variety of sources in the urban area surrounding the monitoring site.

Total suspended particulate concentrations, measured using 24-hour hi-volume air samples, were recorded at three MOE Stations (see Table A-3). All of the stations recorded exceedances of the criterion, but in particular the Mississauga Hospital station recorded numerous exceedances. Much of this could be attributable to traffic or area sources. As well, total suspended particulate matter can be measured in terms of its soiling properties. "Soiling index" is measured by the attenuation of light through a filter on which the particulate has been collected. The unit of measure for this index is the Coefficient of Haze per 1000 feet of air sampled. This parameter was measured at three M.O.E. stations (see Table A-4). The annual average criterion was not exceeded at any of these stations. Daily average levels exceeded the criterion level 19 times at the Oakville station during the three years considered (24-hour exceedances were not available for other stations).

Nitrogen dioxide, nitric oxide and nitrogen oxides were monitored at the M.O.E. stations in the region (see Table A-6). Criteria for 24-hour and one-hour NO_2 levels only, have been defined. At the three stations, all NO_2 levels met these criteria and were in fact well below recommended levels during the 1980 to 1982 period.

Total hydrocarbon levels were measured at the North Etobicoke and Oakville stations (see Table A-7). At present there are no Ontario

nor Federal criteria for hydrocarbons. It should be noted that many of these stations are located near roadways, which may influence levels measured.

Carbon monoxide levels measured at the three M.O.E. stations during the 1980 to 1982 period (see Table A-8) were well below the one-hour criteria (eight-hour averages were not available). Carbon monoxide levels in this region are consistently low.

Ozone was measured at the three M.O.E. stations and has been tabulated for one-hour, 24-hour and one-year averaging periods in Table A-9. Only a one-hour criterion has been defined for Ontario. The one-hour criterion was exceeded occasionally at all three stations over the time period being considered. Ozone exceedances usually are the result of the occurrence of warm stagnant air masses, sunny skies and light to moderate south to southwest winds promoting a build-up of photochemical pollutants and reactions, forming ozone. Periods of photochemical activity generally persist for several days in the Golden Horseshoe, whether they originate locally or as a result of long-range transport into the area, and are generally terminated with the changing of weather systems.

2.2.2 NIAGARA PENINSULA REGION

The SO_2 levels monitored at nine stations in this region are summarized in Table A-1. Annual means exceeded the annual criterion at Chippawa and Thorold, indicating significant sources of SO_2 in the vicinity of these sites. Exceedances of the 24-hour criterion also occurred at these two stations, while other, more rural sites such as Binbrook and Simcoe complied with the criterion. Thorold recorded an unusually large number of one-hour exceedances, with Chippawa and Cheapside showing an order of magnitude fewer exceedances. In general, it appears that background levels of SO_2 in the candidate areas are well below recommended levels

but the potential to exceed criteria exists in the vicinity of local sources.

Total reduced sulphur was measured at four sites in the study area (see Table A-2). As in the case of SO_2, Chippawa recorded numerous exceedances of the H_2S criterion, while the other stations did not record any significant exceedances. A local source near the Chippawa station is indicated by these data.

Total suspended particulate levels are measured in several ways at most stations. Total suspended particulate concentrations, coefficient of haze and dustfall measurements are summarized in Tables A-3, A-4 and A-5. Most stations recorded exceedances of the 24-hour criterion applicable to hi-volume air samples (see Table A-3). Stations situated near industrial facilities (such as Thorold) show the most frequent exceedances. However, rural locations also can be expected to exceed the 24-hour criterion on occasion due to windblown dust from open fields or other area sources. The Coefficient of Haze 24-hour criterion was exceeded only twice at St. Catharines (see Table A-4). Dustfall was measured at several stations based on a sampling period of one month (see Table A-5). Frequency of exceedance data were not available, but the 30-day criterion was exceeded at most stations. As well, many of the annual average levels exceeded the one-year criterion. Relatively little significance is attached to this measurement, in recognition of the substantial contribution that re-entrained dust can make to the levels measured.

Nitrogen dioxide, nitric oxide, and nitrogen oxides (NO_x) were monitored at six stations in this region (see Table A-6). NO_2 criteria were met at all stations. Based on the available NO_2 data, it would appear that nitrogen oxide levels are generally acceptable in this region.

Hydrocarbons were measured and recorded in terms of their

reactive and methane components at three stations (see Table A-7). The significance of the magnitude of these levels is difficult to assess due to a current lack of criteria. However, the general lack of sources near these monitoring sites indicates that a major portion of these levels may represent a "background" component, consisting of both local natural emissions and long range transport into the area.

Carbon monoxide levels in the region were well within the eight-hour and one-hour criteria at Binbrook, Long Point and St. Catharines (see Table A-8).

Ozone levels were measured at four stations in the region (see Table A-9). At all stations the one-hour criterion was exceeded quite frequently. The largest number of exceedances (305) was recorded at Simcoe, while Binbrook only recorded 9 exceedances. Long-range transport of ozone and its precursors, hydrocarbons and nitrogen oxides, is recognized as a major mechanism of ozone formation in the Niagara Peninsula area.

2.3 OTHER POLLUTANTS

Monitoring data for trace contaminants other than the criteria pollutants are not available to any significant extent for the study areas. Consequently, a literature review was undertaken with the objective of providing a general definition of the concentrations of various trace constituents that could be expected to occur in various urban, rural and remote regions of the world, with the objective of providing an approximate concentration range for each type of airshed in the candidate areas. The data have been compiled (see Table B-1, Appendix B) in terms of general contaminant classes, and individual species within the classes. It should be noted that these data, in some cases, may be based upon short-term as opposed to longer-term samples and, therefore,

may not represent long-term "background" concentrations. However, the data tabulated provide a general indication of the potential occurrence of individual contaminants in the atmosphere. Half-hour point-of-impingement standards and guidelines are shown in Table B-2 for comparison (See Appendix B). The tabulated data are discussed briefly under the general categories of organics, metals, nutrients/macroelements and acid gases in the form of an introduction to the tables in Appendix B.

2.4 CONCLUSION

Air quality in Southern Ontario is monitored on a routine basis in order to establish air quality trends, define impacts of existing sources and develop appropriate pollution control strategies. A long-term data base exists for the criteria pollutants, and special studies have been conducted in various areas to define levels of several other types of elements and compounds. Representative data from existing monitoring stations in and near the candidate areas and levels reported in the literature for other trace contaminants have been consolidated here in order to provide a general indication of existing air quality in the areas of interest. Some general conclusions that can be reached are:

- most monitoring activity is conducted in or near urban and industrialized areas that contain significant sources. As a result, relatively few monitoring stations exist within the OWMC candidate areas. Dispersion modelling is thus required in order to estimate prevailing levels in these areas, and can be used in the assessment of the potential impact of OWMC facilities on air quality.

- large concentration differences often occur between stations within a single monitoring network. Higher concentrations are usually the result of impact by a specific local source. Exceedances of ambient air quality

criteria for various averaging times are occasionally reported at specific stations, but can usually be attributed to such local sources and are not necessarily relevant on a regional scale. Routinely monitored components for which criteria have been occasionally exceeded at any location in the Golden Horseshoe area are: sulphur dioxide (1-hour; 24-hour), ozone (1-hour), total reduced sulphur (1-hour), total suspended particulate matter (24-hour, annual), nickel (24-hour), lead (24-hour), and fluorides (24-hour). Both long-range transport and local emissions contribute to these occurrences.

- large concentration ranges have been reported in the literature for many trace components that are not routinely monitored. The concentration ranges cited for rural air in Table B-1 can be considered representative of prevailing levels in air in most portions of the candidate areas. Urban levels are typically about one order of magnitude greater than rural levels. Examples of ubiquitous vapour phase organic constituents that are often recorded in rural air are: ethylene, acetylene, formaldehyde, benzene, toluene, xylenes, naphthalene and several volatile halogenated compounds (e.g., chloroform, trichloroethylene, tetrachloroethylene). Higher molecular weight species that are generally found in low concentrations are: chlorobenzenes, PCB's, several halogenated pesticides and organo-phosphorus compounds. Concentrations of trace metals, associated with particulate matter, are much better characterized, whereas information on concentrations of acid gases such as hydrochloric or hydrofluoric acid is generally lacking due to the inadequacies of currently available measurement methods.

- due to the limitations of the monitoring networks, concentration data appear to be lacking for many components for which Ontario air quality regulations exist, and for many components that have been designated as hazardous. Similarly, regulations do not exist for several components that have been measured. This is particularly evident with respect to the paucity of long averaging period criteria, because of the unknown toxicity of many constituents at ambient concentrations.

- both urban and non-urban concentration ranges of individual constituents that have been reported in Ontario and other locations are generally well below Ontario's short-term air quality standards and longer-term air quality criteria.

3. DISPERSION MODELLING

3.1 INTRODUCTION

A general overview of existing air quality in the Golden Horseshoe has been provided in the preceding section. A discussion of the levels relative to applicable air quality criteria was given. However, the monitoring sites are widely scattered and subject to local sources of contaminants, making them unreliable indicators of trends across the candidate areas. For this reason, dispersion modelling of the region of interest has been carried out, as described below.

3.2 SELECTION OF MODEL

3.2.1 MODEL REQUIREMENTS

In order to estimate the air quality trends across the study area, a dispersion model was sought which met certain fundamental requirements. These were:

a. capability of handling a large number of user specified point and area sources in the same simulation.

b. capability of outputting concentrations at a large number of user-specified receptors in the same simulation.

c. provision of annual average concentrations at the specified receptors.

d. based upon the use of readily available climatological data, i.e., the STability ARray (STAR) data format provided by the Atmospheric Environment Service for St. Catharines, Toronto, and Mount Hope, as well as available mixing height data for the region.

e. incorporation of other spatially varying effects across the study area, such as topography and rural-urban effects.

f. is an established model generally recognized as being suitable for this type of application.

The Industrial Source Complex (ISC) model, recently developed and approved by the U.S. Environmental Protection Agency (EPA), meets these requirements (Bowers et al., 1979). Unlike other earlier models which might be used for this purpose (e.g., AQDM (TRW Systems Group, 1969) and CDM (Busse and Zimmerman, 1973)), it includes such features as the wind velocity vertical profile, variable mixing height with stability, plume rise as a function of downwind distances, and provisions for treatment of stack tip downwash and pollutant decay and deposition. Although some of these features were not used for the present simulation of background air quality, these features may be desirable for later detailed evaluation of the proposed OWMC facility, and, in the interests of consistency in modelling, it was felt desirable to use a model with this capability from the outset.

3.2.2 MAJOR FEATURES OF THE ISC MODEL

The ISC Model treats the dispersion of each point source of emissions as a Gaussian plume, in which the concentration of a contaminant in the plume

follows a normal distribution or "bell" curve. Area sources are treated as finite line sources. Concentrations are calculated at any point downwind as a function of meteorological parameters, i.e., wind speed, atmospheric stability class (A to F), mixing height, as well as a function of downwind distance. In the long-term mode, ISC calculates concentrations at a given receptor for a complete range of meteorological parameters, and the results are weighted according to the frequency of occurrence of these parameters. The frequencies are obtained from the statistical wind and stability summaries over the averaging period of interest (i.e., one year).

The effective height of release for stack emissions is determined from the physical height of release (stack height) plus a plume rise due to buoyancy and momentum of the flue gases. The plume rise may be calculated as a function of distance from the stack, otherwise the ultimate rise is assumed regardless of distance from the stack. The lateral and vertical dispersion coefficients or plume spread are determined as functions of atmospheric stability and distance from the source.

ISC has a rural and an urban mode. In the urban mode, in order to represent the additional dispersive effect of urban heating within an urban heat island, the stable E and F stability categories (and corresponding dispersion coefficients) are redefined as stability category D. Alternatively, the E and F stability categories may be combined and the dispersion coefficients corresponding to the stability category one step more unstable than the indicated stability are used (except A). Different treatments of urban and rural mixing heights are also available.

To simulate the effect of topography where a receptor is located on elevated terrain with respect to a source, the effective height of the plume is reduced by the elevation difference between source and receptor. Further details of the ISC model are available in the model user's guide (Bowers et al., 1979).

3.2.3 MODEL OPTIONS USED

In the present application to "background" air quality modelling in the Golden Horseshoe region of Ontario, only the long-term version of ISC (ISCLT) was used. This provides estimates of annual average pollutant concentrations, rather than the short-term, hourly estimates which might be required in the study of accidents or of compliance of a proposed undertaking with short-term air quality standards or criteria. Furthermore, some features of ISC were not needed at this stage of the OWMC studies. These included the model's capability to represent pollutant deposition, decay and plume downwash. The exclusion of deposition and decay would tend to result in over-estimates of pollutant concentrations in air. However, in view of the prime purpose of the present modelling exercise, namely to estimate relative air quality across the study area, the added complexities involved in modelling these effects was thought to be unjustified. Downwash is primarily of interest in the near field, up to a few hundred metres downwind of the emission source. Thus, in view of the relatively coarse definition required in the present work, this effect was not included. The same reason applied to the exclusion of the model feature in which plume rise is expressed as a function of downwind distance.

The default values given in ISC for the change of wind speed with height were used. This is a function of atmospheric stability. Also, the rural mode of the model was used throughout the study area, since the OWMC candidate areas are in predominantly rural or suburban surroundings. It should be noted that urban areas had been expressly excluded as a result of previous studies (Barton and Dobson, 1982 and 1983). Therefore, atmospheric stability and associated plume dispersion were not modified to take account of the urban heat island effect.

Terrain adjustment, in which the effective plume height is decreased to account for terrain elevations above that of the source, was not included at this stage of the evaluation. Again, the relatively

coarse definition required in the results, as well as the general absence of significant topographic relief in the actual candidate areas, did not justify the additional modelling complexity involved. This may lead to some loss of model accuracy in the immediate vicinity of large emission sources in Hamilton, in the case where the receptors are situated at the top of the Niagara Escarpment. However, it is unlikely that such inaccuracies would be significant when considering the model results on an annual average basis.

3.2.4 MODEL PERFORMANCE

Dispersion modelling is a generally accepted method of describing or predicting the air quality resulting from the emission of pollutants from one or several sources. However, in any particular case, the performance of the model may be affected by inaccuracies in the input data or the mathematical representation implicit in the model (Turner, 1969). These may be summarized as follows:

a. incomplete or inaccurate emission source data, e.g., quantities of pollutants emitted, locations of sources, heights of release,

b. inaccurate or incomplete description of the meteorological phenomena affecting dispersion of the pollutants,

c. inaccurate description of the dispersion process in the model itself,

d. omission of "background" air quality due to transport of pollutants into the study area from elsewhere.

With regard to the emission and meteorological data used in the present study, these were the best data available on a routine basis from

the Ontario Ministry of the Environment (1983[a]), Environment Canada (1982 and 1976) and the Atmospheric Environment Service (1983). However, the possibility of inaccuracies from these sources remains, especially close to major sources or source groupings.

Dispersion models of the type used in ISC have certain known weaknesses in their representation of plume behaviour, such as:

a. increasing uncertainty in plume spreading rate with distance downwind, particularly beyond about 10 km,

b. the two-dimensional representation of the plume trajectory, ignoring possible turning with height or distance due to topographic and atmospheric conditions,

c. lack of a lake breeze model, in which stack emissions may be fumigated to ground level in relatively high concentrations and subsequently recirculated.

Nevertheless, validation studies of dispersion models in urban environments (summarized by Turner, 1979) suggest that ISC, when used in the long-term mode in Southern Ontario, should produce results to within approximately 50% of monitored values. As noted previously, this may not be achieved in certain areas under study (e.g., due to the proximity of large emission sources to receptors on high ground). However, the constraints imposed on the candidate areas in early atmospheric dispersion assessments eliminates many of the atmospheric and topographical factors which might result in model inaccuracies.

Finally, it should be emphasized that model results are used here primarily to compare air quality in various candidate areas. Thus, only relative values are of interest and systematic biases in results due, for example, to the omission of "background" attribute to long-range

transport can be disregarded. Furthermore, spatial detail around large sources is not required for this application. In addition, monitoring data are available in certain locations to confirm the modelling results.

3.3 MODEL IMPLEMENTATION

3.3.1 EMISSIONS INVENTORY

For the purposes of modelling existing air quality in the Golden Horseshoe region, an inventory of emission sources of sulphur dioxide (SO_2), nitrogen oxides (NO_x), total suspended particulate (TSP) and total hydrocarbons (THC) was assembled, based on the most recent data available from the Ontario Ministry of the Environment (1983[a]). The base year for these data is 1980. The pollutants were chosen partly with the potential emissions of a waste incinerator in mind, and partly because of their inclusion in the MOE inventory.

In the inventory input to the ISC model, sources were summarized in two categories; point and area sources. Point sources were taken to be from relatively large industrial or commercial facilities with an average emission rate of 0.6 g/s or greater (for each pollutant), and/or stacks greater than 18 m. All known sources in the Niagara Peninsula area, west as far as Nanticoke, and in the area between Hamilton and Toronto were included, as well as all sources in the Borough of Etobicoke and the largest sources elsewhere in Metropolitan Toronto.

Annual average emission quantities were obtained for each source, together with the UTM coordinates. However, the impact of large point sources on air quality, at least within a few kilometres of each source, depends not only on the emissions (mass per unit time), but also on the stack parameters which determine the effective height of the plume. These include the stack height, exit diameter, and the exit velocity and temperature of the flue gases. Accordingly, such data were

also included in the inventory and subsequently input to the ISC dispersion model. Between 64 and 180 point sources were inventoried in this way for each of the four pollutants, with the number of sources considered depending on the pollutant.

Area sources are intended to represent the aggregate of smaller sources in a given area, comprising emissions from small industrial or commercial establishments, institutional buildings, residences and vehicular traffic. In the Niagara Peninsula region, the area sources chosen for this study were based on a regular 5 km grid. In the Halton/Peel and Hamilton regions, a 2 km grid was used, in consideration of the smaller OWMC candidate areas and the greater concentration of emission sources in this region. The emissions inventory in all regions consisted of data on the quantities of emissions from each grid element (annual average) and the UTM coordinates of the southwest corner of the element. A total of 885 grid elements was used. In some areas, the MOE area source inventory was found to be incomplete. For example, data were almost totally lacking for the Region of Peel. In these cases, an estimate was derived, based on the nature of the area, e.g., residential, light industrial, and the portion of the grid element so developed.

3.3.2 MODEL RECEPTORS

The OWMC candidate areas considered in this phase of the site selection studies are in two distinct regions of the Golden Horseshoe. The first, in the Niagara Peninsula, extends from a point approximately 20 km northeast of Simcoe to a point within about 5 km of Fort Erie. The second is in the Regions of Halton and Peel, west of Toronto, and includes areas to the north and south of Brampton and to the south of Milton. As with the source inventory, model receptors were defined based on a 5 km square grid in the Niagara region, and a 2 km square grid in Halton/Peel. Again, the smaller candidate areas and greater concentration of emission sources in the latter region suggested a finer model definition.

The model receptors used in the ISC model were defined to be at the centre of each grid element. In each of the two regions, a rectangular array of elements was specified to encompass the OWMC candidate areas and an influence area extending 5 km beyond the boundaries of the candidate areas. This was intended to include areas which would experience the greatest air quality impact should an incineration facility with a stack of 100 m or less be located at or close to the edge of a candidate area. Thus, the results of the modelling could be used to compare air quality across the entire area of interest.

3.3.3 METEOROLOGICAL DATA

The dispersion modelling exercise required historical hourly wind observations and other meteorological data from which Pasquill-Gifford stability class frequencies could be determined. (Atmospheric Environment Service, 1983; Environment Canada, 1982 and 1976.) As only selected stations monitor these parameters on a regular basis, records from three representative stations were used for the entire study area. However, these records include the full range of meteorological conditions experienced at these stations.

The candidate areas in the Peel/Halton region were represented by the last 10 years of climate data from Toronto Pearson Airport. Winds at the Toronto station are predominantly from the north, but also include strong westerly to southerly components. Ground level wind speeds in the range of 4 to 5 m/s were experienced most frequently. The neutral stability class occurred approximately 55% of the time with the stable class 28% of time, and unstable only 16% of the time.

Mount Hope Airport data were used to represent the western portion of the candidate areas in the Niagara Peninsula region. Winds at this station are predominantly from the west and southwest, with a

moderate northeast component. Wind speeds most frequently experienced range from 4 to 8 m/s. Because of the slightly higher wind speeds compared to Toronto Airport, the neutral stability class occurred more frequently, (i.e., 68% of the time). Stable and unstable classes occurred approximately 13 and 19% of the time, respectively.

The stability frequencies estimated from the St. Catharines meteorological observations were felt to have been influenced by the presence of the lake, and would not have represented general dispersion conditions further south in the Niagara Peninsula. On the other hand, the St. Catharines wind data set was felt to be sufficiently representative of the east end of the Niagara Peninsula and was the most complete data set available for this region. Therefore, the eastern portion of the candidate areas in the Niagara Peninsula was represented by St. Catharines wind data, with stability frequencies derived from observations at Mount Hope. Winds in the region experienced relatively strong southwest and westerly components, with the most frequent wind speeds recorded in the range of 6 to 8 m/s.

Wind conditions across the candidate areas vary slightly, as represented by data at the three stations considered. However, significant easterly components are absent in all areas, with westerly, southwesterly and northerly components dominating. Winds greater than 8 m/s and less than 2 m/s are experienced very infrequently, with the most common wind speeds occurring in the 4 to 8 m/s range. The St. Catharines and Mount Hope stations appear to experience higher wind speeds than does Toronto.

3.3.4 ISC MODEL RUNS

As noted in the previous section, three separate descriptions of dispersion climatology were developed for Halton/Peel and the east and west portions of the Niagara Peninsula region. This, together with the

need to minimize the risk of an abortive computer run, with the associated costs, led to the decision to divide the modelling into three separate runs per pollutant (total of twelve runs). Thus, Halton/Peel, Niagara east and Niagara west were modelled separately with distinct meteorological data input. However, a common emissions inventory was used in the two Niagara simulations, including all sources east of Nanticoke and south of Burlington. The inventory used in the Halton/Peel simulation included all sources between Burlington and Toronto and extended north as far as Caledon.

3.4 MODELLING RESULTS

The integrated results of the modelling exercise are presented in the form of isopleth maps for the four pollutants: SO_2 (Figure 3), NO_x (Figure 4), TSP (Figure 5) and THC (Figure 6), and are located at the end of Chapter 3.

3.4.1 PREDICTED LEVELS

SO_2 levels predicted by the model are approximately 10 ug/m^3 near the southern portions of areas 5 and 15, (south of Milton), increasing eastwards to levels of approximately 30 ug/m^3 through area 14 (south of Brampton) and decreasing again to about 10 ug/m^3 at the northwestern end of A-1 (north of Brampton). In the Niagara Peninsula region, concentrations of approximately 10 ug/m^3 are predicted through the majority of the areas, increasing in the eastern areas to reach concentrations of approximately 30 ug/m^3 near Niagara Falls.

NO_x isopleths indicate that the highest concentrations predicted in the Halton/Peel region are about 45 ug/m^3, in area 14 near Brampton, with values decreasing to between 20 and 30 ug/m^3 in area 4 (near Streetsville), and to between 15 and 5 ug/m^3 in areas 5 and 15 (south of Milton). In area A-1 (north of Brampton), levels are between

10 and 30 ug/m^3. Concentrations of up to 20 ug/m^3 are predicted south of Hamilton, increasing steadily to a maximum of 60 ug/m^3 at the northern extremities of areas 13 and 19 near Niagara Falls.

Predicted TSP levels of between 6 and 10 ug/m^3 are indicated near Brampton in areas 14 and 4, decreasing to between 2 and 5 ug/m^3 through areas A-1 (north of Brampton), and 5 and 15 (south of Milton). It should be noted that these values represent anthropogenic point sources only. The isopleths south of Hamilton indicate levels of approximately 7 ug/m^3 at the west end of area 7 (north of Nanticoke), increasing eastward across the areas, reaching a maximum level of approximately 60 ug/m^3 near Niagara Falls, at the north end of area 13.

In Halton/Peel, predicted values for THC reach values of approximately 80 ug/m^3 in area 14 (south of Brampton), decreasing to approximately 20 ug/m^3 at the northwest end of area A-1 (north of Brampton) and to about 10 ug/m^3 near the Niagara Escarpment (areas 5 and 15). South of Hamilton, values of between 10 and 30 ug/m^3 were predicted, increasing eastward to approximately 80 ug/m^3 near Niagara Falls.

In order to compare the air quality in each candidate area on a relative basis, a mean concentration level was estimated for each area (areas 4 to 19 and area A-1). These values were then normalized to the mean of all areas, for each pollutant, resulting in the indices provided below. Index values greater than 1.0 indicate areas of higher than average loadings of each pollutant, and values less than 1.0 represent areas of lower than average loadings.

Pollutant Loading Index

Candidate Area	SO_2	NO_x	TSP	THC
A-1	1.1	0.9	0.2	1.2
4	1.7	1.1	0.5	1.2
5	0.9	0.4	0.2	0.7
6	1.0	1.0	0.6	0.8
7	0.6	0.6	0.5	0.5
8	0.6	0.8	0.7	0.7
9	0.7	1.0	0.9	0.8
10	0.7	1.1	0.9	1.0
11	0.8	0.8	1.1	0.8
12	1.3	1.1	2.8	1.1
13	1.0	1.7	2.8	2.0
14	2.2	1.9	0.7	1.7
15	0.7	0.3	0.1	0.5
16	0.7	0.7	0.5	0.6
17	0.7	0.7	0.6	0.6
18	1.0	1.0	1.1	0.8
19	1.4	2.0	2.8	2.0

From this analysis, areas 19 and 13 (near Niagara Falls) and 12 (near Welland) emerge with the highest loadings of all four pollutants. Areas 4 and 14 (south of Brampton) are predicted to experience relatively high loadings of SO_2, NO_x and THC. The remaining areas show predicted levels comparable to or below the mean value for each pollutant. The modelling results are supported, at least qualitatively, in that the five areas with the highest relative loadings are located nearest to heavily industrialized regions, and as such, can be expected to show the highest concentrations. The lowest levels were experienced in candidate areas 5, 7, 15, 16 and 17, near Milton and directly south of Hamilton. Areas 5 and 15 are not situated close to any large emission sources. The model indicates that, on an annual average basis, the Hamilton sources do not significantly impact on areas 7, 16 and 17.

3.4.2 PREDICTED VS MEASURED LEVELS

A comparison of predicted versus monitored data was undertaken to validate the results of the model, in at least a qualitative fashion.

Modelled SO_2 and NO_x results correlated very closely with the measured values for the study area (Section 2). Such good agreement can be attributed to the fact that ambient levels of these pollutants are primarily a result of local point and area sources. However, TSP and THC modelled results were much lower than measured values.

Measured TSP levels include fugitive dust contributions from a number of sources not included in the model. Background TSP loadings attributable to re-entrained dust from roads, fields and other open sources, and long-range transport of fine particulate matter, may account for as much as 35% to 47% of the observed values (ORF et al., 1982). If this value is added to all of the modelling results, there is good agreement between measured and predicted values.

Very large discrepancies are apparent upon initial consideration of the modelled versus measured THC data. Aside from possible measurement inaccuracies, the difference between the two values most likely represents significantly large long-range transport components combined with background levels of methane and other naturally occurring constituents. It has been estimated that natural sources may comprise up to 80% of ambient total hydrocarbon levels (U.S. EPA, 1978), and natural sources have not been included in this inventory. Consideration of this factor would bring the measured and the predicted levels to the same level of magnitude.

3.5 CONCLUSION

Annual average levels of the criteria pollutants (SO_2, NO_x, TSP and THC) have been modelled for the candidate areas. Comparison of the results with actual monitoring data confirms the basic validity of the results and observed discrepancies can be explained in terms of source contributions not included in the model.

The spatial trends defined by the isopleth maps of each pollutant provide a relative comparison of the existing air quality in each candidate area. Candidate areas 12, 13, 19, and 4 and 14 (near Niagara Falls and south of Brampton) are predicted to experience the highest concentrations of SO_2, NO_x, TSP and THC combined, while areas 5, 15, and 7, 16 and 17 (near Milton and south of Hamilton) are predicted to experience the lowest concentrations of all pollutants.

In addition to providing a relative assessment of the existing air quality in the various candidate areas, the modelling results also provide a general definition of existing air quality relative to existing air quality criteria. Thus, this information can be used as an important component in the assessment of potential sites and candidate sites on both an absolute (with respect to air quality criteria) and relative (site to site comparison) basis.

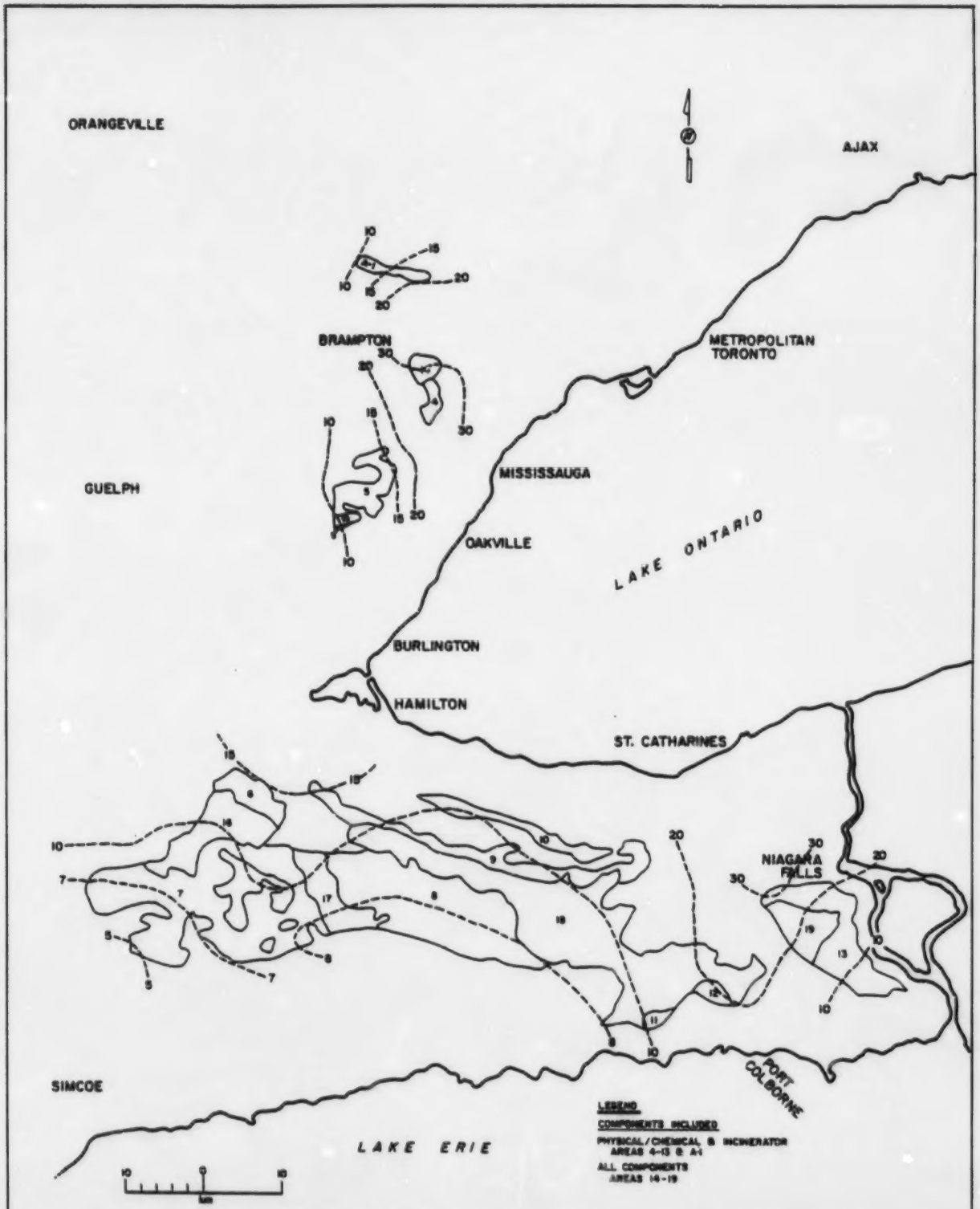

FIGURE 3 INDUSTRIAL SOURCE COMPLEX (LONG TERM) MODEL RESULTS FOR THE CANDIDATE AREAS - ANNUAL CONCENTRATIONS, SULPHUR DIOXIDE (ISOPLETHS IN $\mu g/m^3$)

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FIGURE 4 INDUSTRIAL SOURCE COMPLEX (LONG TERM) MODEL RESULTS FOR THE CANDIDATE AREAS - ANNUAL CONCENTRATIONS, NITROGEN OXIDES (ISOPLETHS IN $\mu g/m^3$)

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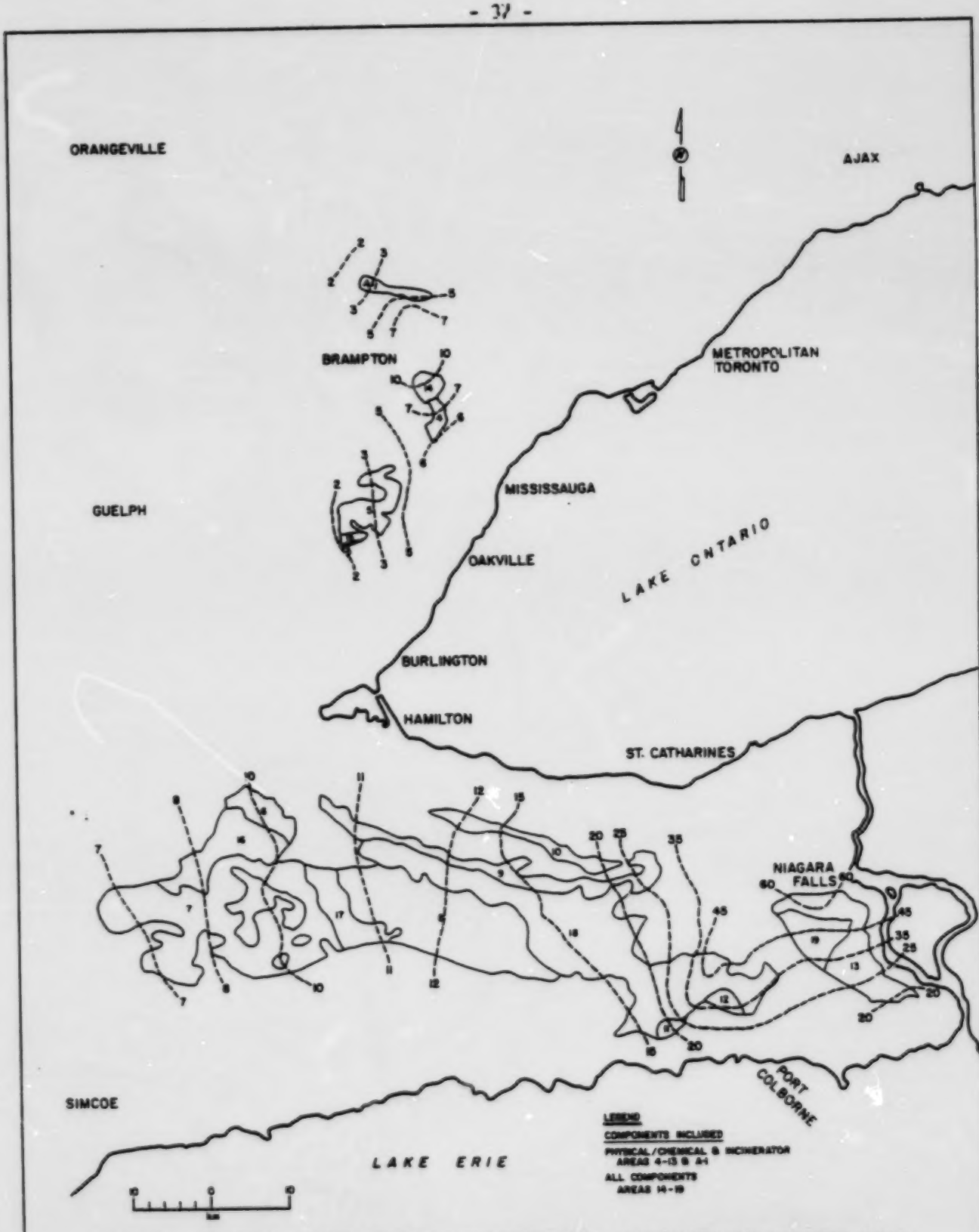

FIGURE 5 INDUSTRIAL SOURCE COMPLEX (LONG TERM) MODEL RESULTS FOR THE CANDIDATE AREAS - ANNUAL CONCENTRATIONS , TOTAL SUSPENDED PARTICULATES (ISOPLETHS IN $\mu g/m^3$)

February, 1984 Project 83.3

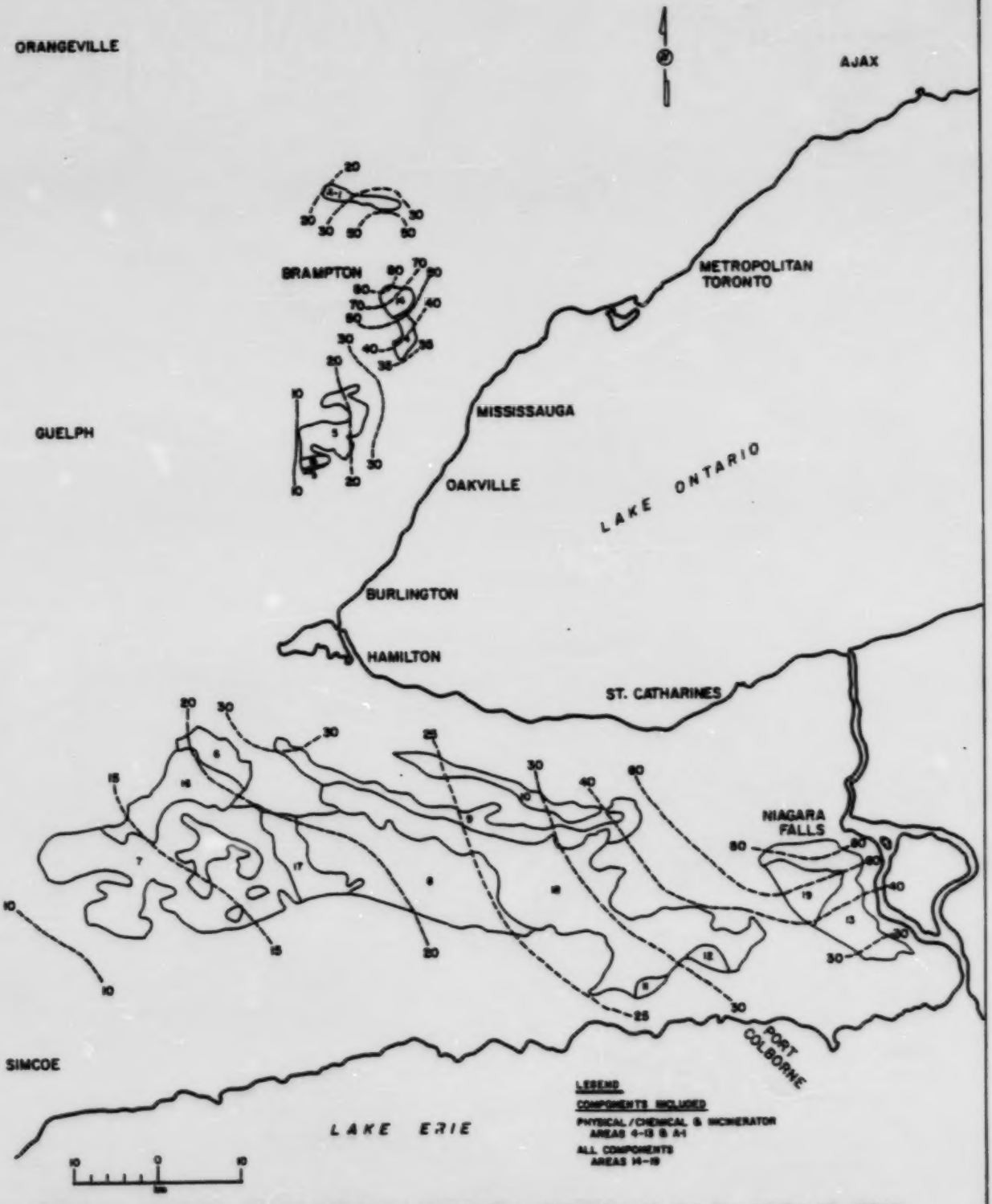

FIGURE 6 INDUSTRIAL SOURCE COMPLEX (LONG TERM) MODEL RESULTS FOR THE CANDIDATE AREAS - ANNUAL CONCENTRATIONS , TOTAL HYDROCARBONS (ISOPLETHS IN $\mu g/m^3$)

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PART 2

COMPARATIVE EVALUATION OF SITES

4. INTRODUCTION

Part 1 of this report summarized the available data on emission sources and prevailing air quality in the Golden Horseshoe, as well as the methodology and results of dispersion modelling of criteria pollutants in the OWMC candidates areas. This information provides the basis for a comparative assessment of the candidate areas in that it defines the "background" levels and patterns of criteria pollutants and, by analogy, other potential emissions from the OWMC facility.

As part of the Phase 3 site selection activity, the information generated in Part 1 was used along with a qualitative assessment of other air quality factors, to provide a preliminary comparative evaluation of a list of potential sites selected by OWMC. Due to the scale at which air quality phenomena occur and the spatial resolution of the important variables available from existing data, it was not considered necessary or feasible to use atmospheric factors in both the constraint mapping process (site areas selected from candidate areas) and the site screening process (potential sites selected from site areas). Therefore, the list of potential sites was based on a process using factors other than those relating to air quality, although consideration was given in the earlier identification of candidate areas to avoiding areas with poor or complex atmospheric dispersion conditions (see Barton & Dobson, 1983). The evaluation and ranking of potential sites based on air quality considerations are described in this part of the report. The remaining sections of Part 2 are concerned with the methodology to be followed in further, more detailed, evaluation of candidate sites in Phase 4 of the OWMC site selection process.

5. PRELIMINARY SITE ASSESSMENTS

5.1 INTRODUCTION

Fourteen potential incinerator locations, whether part of an integrated or partially integrated site, were identified by OWMC in the site screening process (OWMC, 1983[b]). An initial comparative evaluation of these sites has been undertaken in terms of local factors and circumstances which could play a role in determining the relative potential environmental impact of air emissions at each of the sites. Factors which have been considered at each site include local topography, existing air quality and local receptors. The choice of these factors is consistent with two key site selection objectives: to site the facility components in airsheds that have atmospheric dispersion characteristics which will protect air quality, and thus human health and aquatic and terrestrial ecosystems; and to site the facility components to minimize the potential for exposure of populations to emissions. The sites have been ranked on a scale having four levels of relative potential constraint - "none", "minor", "moderate" and "major" (see Section 5.3 for definitions).

5.2 SITE DESCRIPTIONS

Visits to all of the potential sites were undertaken during January and February, 1984. Each site was qualitatively assessed based on visual inspection, reference to topographic maps and the existing air quality. Factors used to determine potential levels of constraint at each site are

documented on standardized "factor sheets" in Appendix C, and are discussed below:

Existing Air Quality - Results from Part 1 of this report were used to develop a composite air quality parameter for each site by summing the SO_2, NO_x, TSP and HC levels in ug/m^3. Comparison of the values of this parameter allowed the sites to be categorized as having relatively low, moderate or high existing pollutant levels.

Topography - The geographical areas where topography was anticipated to have the potential to severely limit the dispersion of pollutants under various meteorological conditions were eliminated previously as part of the candidate area selection process. However, for the initial comparative evaluation, topography at each of the potential sites was considered on a more localized scale in anticipation of less widespread situations not accounted for in the previous evaluation. The following types of features were noted during the site visits: pronounced depressions or low lying areas, hilly terrain, and prominant features near to or on the site. Small scale local depressions are potential "sinks" for any low level emissions (especially accidental releases) from the facility, and this would be of special concern in the release of heavier-than-air vapours. For example, a river valley will tend to contain and channel such emissions. Prominent features, of a height greater than approximately 10 m, offer the potential for direct impingement from stack or other emissions. The existence of these features on or near the sites was used to identify potential constraints at each site; for example, a relatively flat site would be classified as having no potential constraint and a very hilly site ranked more restrictively.

Receptors - Heavily urbanized areas and specialty agricultural lands were eliminated previously as part of the candidate area selection process, although for reasons other than air quality. As a result,

overlap of the candidate sites with such receptors has already been minimized to a substantial degree. However, any potential local receptors were noted during the site visits. A rough estimate of the population near each site was made for the purpose of assessing the probable relative exposure to air emissions (more refined population estimates have been made by other consultants (IER, 1984)). A site with a very small surrounding population will generally be considered more desirable, from the point of view of exposure to atmospheric emissions, than a site with a relatively large population nearby. Apartment buildings within a few kilometres of the site were also important to consider, as they may be subject to direct impingement of the stack plume from an incinerator.

Other local features which might represent potential receptors of air emissions were noted. However, it was beyond the scope of this initial evaluation to assess the significance of these specific features. For example, no attempt was made to assess the relative significance of agricultural receptors and other land uses. Evaluations of such features, and any resulting site rankings, are dealt with in other reports on parallel work conducted by other consultants (see Ecologistics, 1984). The synthesis of all consultants work with the air quality/dispersion factors is discussed in a separate report (M.M. Dillon, 1984).

It should be noted, that this initial comparative evaluation considered fourteen potential incinerator sites as part of seventeen possible integrated and partially integrated options. These siting options are LF-10W, LF-11W, LF-1E, LF-3E, LF-3C, LF-8C, LF-9C, LF-4N, LF-2N/PI-1A1, LF-2N/PI-1N, LF-4N/PI-1N, LF-1C/PI-18E, LF-10W/PI-2W, LF-11W/PI-2W, LF-1E/PI-27E, LF-4N/PI-13N, LF-2N/PI-13N.

5.3 INITIAL COMPARATIVE EVALUATION

Detailed study of the site descriptions and constraints identified at each site allowed the grouping of the sites into four relative

categories of potential constraint. Existing pollutant levels were generally considered to be a constraint only if levels were indicated to be relatively high. In general, existing air quality wasn't weighted as heavily as the topographical and potential population exposure constraints, as it is not considered in relation to air quality criteria and the incremental impact of the OWMC facility has not been included in this preliminary evaluation. Hilly ground, proximity to elevated receptors, and proximity to populated centres constituted the major constraints, with several combinations at a site increasing the level of constraint.

A "no constraint" ranking indicates that a site has no apparent constraints relative to the other sites. Table 1 (located at the end of Section 5) briefly describes three sites (LF-3C, LF-8C and LF-9C) under this classification. These sites are relatively remote from population centres, have no significant topographic features and have relatively low levels of airborne pollutants.

Three sites are listed in the "minor constraint" category (i.e., LF-10W, LF-11W, PI-13N), and are described briefly in Table 2. Sites LF-10W and LF-11W have rolling to hilly terrain but are relatively remote. Site PI-13N is situated relatively near to a small settlement, on flat lands and is situated close enough to a deep river valley to warrant slightly more constraint than LF-10W and LF-11W. In each case, the small potential topographical or population exposure warranted classifying these three sites as having a minor potential constraint.

Seven of the remaining sites were classified as potentially having a "moderate constraint". These are: PI-2W, LF-1E, LF-3E, PI-27E, PI-18E, PI-1N, and PI-1A1. This ranking indicates the existence of a combination of two or three minor constraints at a site, or the existence of a single, more moderate constraint. The combination of potential topographical (including elevated receptors) and population exposure constraints is evidenced at sites PI-2W and PI-1N. Moderate potential

population exposure as a single factor presents a constraint at sites PI-18E and PI-1A1. High existing pollutant levels relative to other candidate sites, combined with other factors, also results in a moderate constraint ranking, i.e., at sites LF-1E, LF-3E and PI-27E. Table 3 summarizes the descriptions of these sites.

One site, LF-4N, appears to involve more severe constraints than do any of the other sites, and has been ranked as having a potential "major constraint". It is described in Table 4. Site LF-4N is located just within the constraint area associated with topographical features and had previously been excluded as a candidate area for an incinerator in the Interim Phase 3 report "Atmospheric Dispersion Influences: Golden Horseshoe" (Barton and Dobson, 1983). As stated in the report, an incinerator facility located within this zone presents the potential for direct impingement of emissions on the face of the Niagara Escarpment under certain meteorological conditions. However, the extent of this zone should be interpreted as a general demarcation only; detailed assessments of likely impingement patterns are required before concluding that significant adverse impact actually would occur. Due to its marginal location, site LF-4N was considered, and is ranked as presenting a major potential constraint.

5.4 CONCLUSION

Fourteen potential sites were assessed based on drive-through inspections, topographical maps and existing air quality (as defined in Part 1 of this report). The sites were ranked as having potential for "no constraint", "minor constraint", "moderate constraint" and "major constraint", relative to one another. Sites LF-3C, LF-8C and LF-9C are included in the "no constraint" group; sites LF-10W, LF-11W and PI-13N were ranked as "minor constraint"; sites PI-2W, LF-1E, LF-3E, PI-27E, PI-18E, PI-1N, and PI-1A1 were classified as "moderate constraint", and site LF-4N was placed under the "major constraint" classification.

TABLE 1

Site Rankings Relative to One Another in Order of Preference

On The Basis of Air Pollution Potential

No Apparent Constraint

Site No.	Existing Pollutant Levels	Topography	Receptors
LF 3C	Moderately low	Flat to slightly hilly	Some farmhouses. Site near Welland R. and small conservation area. Mainly cultivated land.
LF 8C	Moderate	Relatively flat.	Some farmhouses. Mainly cultivated lands and woodlots.
LF 9C	Moderate	Relatively flat.	Some farmhouses. Mainly cultivated lands and woodlots.

TABLE 2

Site Rankings Relative to One Another in Order of Preference

On the Basis of Air Pollution Potential

Minor Potential Constraint

Site No.	Existing Pollutant Levels	Topography	Receptors	Basis for Minor Potential Constraint
LF-10W	Low	Rolling, very hilly	Some farmhouses. Relatively remote. Approximately 10 km from Mt. Hope, 9 km from Ancaster. Cultivated land; occassional woodlot.	Topography
LF-11W	Low	Relatively rolling; surrounding land very hilly.	A number of farmsteads near and on site. Relatively remote. Approximately 8 km from Mt. Hope, 7 km from Ancaster. Cultivated land; occasional woodlot.	Topography
PI-13N	Low	Relatively flat. Near deep river valley.	Some farmhouses. Approx. 7km from Milton. Numerous rural homes along Fifth Line in close proximity to site. Cultivated land.	Population exposure and topography.

TABLE 3

Site Ranking Relative to One Another in Order of Preference

On the Basis of Air Pollution Potential

Moderate Potential Constraint

Site No.	Existing Pollutant Levels	Topography	Receptors	Basis for Moderate Potential Constraint
PI-2W	Moderate	Very hilly terrain.	Some farmhouses. South of Duff's Corners. Cultivated land; occasional woodlot. Approx. 5 km from Ancaster, 8 km from Mt. Hope.	Topography and population exposure.
LF-1E	Relatively high.	Quite flat.	Some farmhouses. Site approximately 6 km from Welland and 6 km from Niagara Falls. Raised bridge (∿30 m) on nearby railway presents possible constraint. Some cultivated lands and woodlots.	Elevated receptor, population exposure and air quality.
LF-3E	Relatively high. Ford Glass Plant <1 km away.	Relatively flat.	Some farmhouses. Site approximately 5 km from Niagara Falls and 7 km from Welland. Site wooded with some cultivated land.	Population exposure and air quality.

TABLE 3

(Continued)

Site No.	Existing Pollutant Levels	Topography	Receptors	Basis for Moderate Potential Constraint
PI-18E	Moderate to moderately high.	Relatively flat.	Several rural settlements, small industrial buildings. Approx. 2 km from outskirts of Welland.	Population exposure and air quality
PI-1N	Low	Flat. Approx. 6 km from base of escarpment.	Some farmhouses. Approx. 4 km from Milton.	Topography and population exposure
PI-27E	Quite high. Close proximity to Ford's Niagara Glass Plant. Very close to QEW.	Predominantly flat.	Some farmhouses. Approximately 3 km from the outskirts of Niagara Falls. Predominantly cultivated lands some woodlots.	Population exposure and air quality.
PI-1A1	Moderate	Relatively Flat	Some farmhouses. Approximately 2 km from the outskirts of Brampton.	Population exposure.

TABLE 4

Site Ranking in Order of Preference

On the Basis of Air Pollution Potential

Major Potential Constraint

Site No.	Existing Pollutant Levels	Topography	Receptors	Basis for Major Potential Constraint
LF-4N	Low	Very flat. Approx. 3.5 to 4.5 km to two faces of escarpment.	Few farmhouses and rural homes. Approx. 4 km from Milton.	Topography and population exposure.

6. LOOKING AHEAD

6.1 INTRODUCTION

At this stage in the development of the project, when size and process details have not been fixed, it is preferable to compare sites primarily in terms of local atmospheric dispersion patterns and local receptor characteristics. This avoids undue reliance on assumptions regarding specific contaminant levels which would result from emissions from the facility. However, the availability of preliminary emission estimates for the OWMC facility will permit at least a preliminary assessment to be undertaken in more absolute terms, i.e., using predicted contaminant concentrations resulting from incinerator stack emissions. Therefore, a two-part methodology is proposed for the detailed assessment of the candidate sites.

6.2 RELATIVE IMPACT ASSESSMENT

The first component of the proposed methodology consists of a strictly relative comparison of the candidate sites involving no assumptions regarding specific emission rates or components.

Mathematical dispersion modelling would be used to represent the dispersion of "unit" emissions from both the incinerator stack and from sources of fugitive emissions. The modelling would be based on wind speed, direction and atmospheric stability frequencies representative of each location. The modelling would be performed out to a distance of

approximately 20 km from each site. The results for each site would consist of a set of isopleths or contours of concentration at ground level. These hypothetical isopleths would represent the annual average pattern of dispersion and would reflect the general conditions of meteorology prevailing in a given area, as represented by the candidate site.

The comparative evaluation would then require the following additional input data:

- o population distribution around each site.
- o distribution of "sensitive" crops around each site. The identification of "sensitive" crops would be done in terms of factors such as: potential criteria and non-criteria contaminants emitted from the OWMC facility; the order of magnitude of the expected levels of these contaminants at ground level; and the effects on the various crops grown in the area at these levels.
- o distribution of livestock around each site.

At each candidate site, the above input data would be combined with the concentration isopleths to determine a series of exposure indices for population, crops and livestock. It should be emphasized that these indices would be for site comparison purposes only; although their relative values between sites would be significant, their absolute values would not. However, sites exhibiting relatively high indices could be interpreted as receiving the greatest potential for impact by facility emissions, by virtue of local conditions.

6.3 ABSOLUTE IMPACT ASSESSMENT

In the second part of the detailed evaluation, the potential impact of the

OWMC facility at each site would be assessed in more absolute terms. This would involve the use of estimated emission rates for the facility and the background air quality modelling results discussed in preceding sections of this report. The combined impact of both OWMC and other sources on air quality at each candidate site would be assessed in terms of air quality criteria. In this way, the potential for significant adverse impact from the combined contribution of both the OWMC facility and other sources could be evaluated.

The contribution of the facility would be calculated by multiplication of the "unit" concentration isopleths discussed above by the appropriate emission factors for each pollutant category of interest. The adjusted isopleths would then be superimposed and added to the previously determined background levels of SO_2, NO_x, TSP and THC to estimate the total concentrations in each grid to be expected as a result of siting the facility within each candidate site. The projected levels could then be compared to each other and to relevant criteria in order to assess in a more absolute way the potential for significant adverse impact to occur at each site. In addition, elevated receptors around the sites, e.g., high ground or existing and planned high-rise buildings, would be assessed for potentially high concentrations of incinerator stack emissions. The potential for any significant deposition of stack emissions would also be assessed.

7. CONCLUSION

A detailed assessment of air quality in and around the OWMC candidate areas has been undertaken as one component of the overall evaluation of the suitability of these areas for the siting of the OWMC facilities. Both ambient air quality monitoring data for the study area and information from the literature have been used to characterize the levels of pollutants which can be expected to occur in and around the candidate areas. Both "criteria" pollutants and other trace contaminants have been considered.

Occasional exceedances of air quality criteria for pollutants such as SO_2, O_3, TRS and TSP have been recorded at specific monitoring stations in or near the candidate areas. These exceedances can be accounted for in terms of specific local sources, dust re-entrainment or larger scale phenomena such as long-range transport. In general, however, prevailing levels of air pollutants in terms of commonly measured pollutants, are below the applicable criteria. While there is very little monitoring data on other trace atmospheric constituents, published information suggests that prevailing levels in the candidate areas should be well below Ontario's air quality standards and other applicable criteria.

The large distances existing between air quality monitoring stations in the study areas necessitated the use of dispersion modelling

techniques to estimate prevailing air quality patterns and levels. Detailed emissions data for the regions in and around the candidate areas were tabulated, along with climatological information specific to the study areas. This information was used as input to a regional dispersion model. This model was used to estimate annual average concentrations of SO_2, NO_x, TSP and THC on a predetermined grid of receptor points in and around the candidate areas.

Candidate areas 4, 12, 13, 14 and 19 (near Brampton and Niagara Falls) were shown to have the highest levels, while candidate areas 5, 7, 15, 16 and 17 (near Milton and south of Hamilton) were shown to have the lowest levels of the four pollutants modelled. The range of values estimated by the model for SO_2 (10 to 30 ug/m^3 through all areas) agreed well with the range of values measured at monitoring stations. NO_x levels estimated by the model ranged from 15 ug/m^3 to 45 ug/m^3, also in close agreement with measured values. The model predicted TSP levels in the range of 5 ug/m^3 to 45 ug/m^3. However, the model only accounts for anthropogenic sources. Natural sources and fine particulate matter transported into this region are thought to account for approximately 35% to 47% of measured values. The addition of this estimated "background" component to the model's output results in close agreement with measured levels. THC levels in the range of 10 ug/m^3 to 100 ug/m^3 were estimated by the model as representative of the candidate areas. As background and natural total hydrocarbon components can constitute up to 80% of measured values, estimated values were of the same level of magnitude as measured values, after this component had been accounted for.

A number of potential sites were assessed based on local air quality factors, and were then ranked relative to one another according to potential constraints. Sites LF-3C, LF-8C and LF-9C were ranked as having "no constraints"; sites LF-10W, LF-11W and PI-13N were ranked as having "minor constraints"; sites PI-2W, LF-1E, LF-3E, PI-27E, PI-18E,

PI-1N, and PI-1A1 were classified as having "moderate constraints", and site LF-4N was placed under the "major constraint" category.

As a continuation of this study, future studies will evaluate all candidate sites using a two-phased method. The first phase would combine modelled ground level concentration contours based on a unit emission rate from the facility with crop sensitivity, livestock and human population data, to provide a set of relative impact indices. The second phase of the comparative assessment would be more absolute, in that both estimated facility emission rates and background air pollutant levels would be combined to estimate the overall air quality expected in the vicinity of the sites. These levels would be compared with each other and with applicable air quality criteria to judge the relative potential for significant impacts at each site. Impacts on any nearby elevated receptors and the potential for significant deposition of stack emissions would also be assessed.

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APPENDIX A

Measured Ambient Air Quality
Levels Representative of
the Candidate Areas

TABLE A-1

Ontario Criteria:
Annual 55 $\mu g/m^3$
24-Hour 275 $\mu g/m^3$
1-Hour 690 $\mu g/m^3$

Prevailing Sulphur Dioxide Levels ($\mu g/m^3$) in the Golden Horseshoe

Area	Annual Arithmetic Mean			Maximum 24-Hour Level*	Maximum 1-Hour Level*	Total Number of Criteria Exceedences*		
	1982	1981	1980			Annual	24-Hour	1-Hour
Halton-Peel								
Airport	8	11	11	140	990	0	0	1
Beckett-Sproule	14	11	16	100	1010	0	0	1
Hanlan	11	14	8	125	985	0	0	2
Meadowvale	11	14	8	250	1100	0	0	14
Mississauga	22	16	14	220	1345	0	0	4
N. Etobicoke	16	16	16	110	605	0	0	0
Oakville	19	14	19	165	825	0	0	1
Trafalgar	8	14	8	150	1035	0	0	3
Niagara Peninsula								
Binbrook	16	16	14	110	385	0	0	0
Cheapside	14	14	14	140	770	0	0	5
Chippawa	30	80	82	385	1650	2	13	38
Fort Erie	19	27	19	165	385	0	0	0
Long Point	14	16	8	85	300	0	0	0
Niagara Falls	8	11	19	165	300	0	0	0
Simcoe	11	11	19	110	604	0	0	0
St. Catharines	14	19	11	110	385	0	0	0
Thorold	33	110	88	1070	4475	2	48	403

* Over entire collection period shown here.

Sources: •Ontario Hydro, 1983
•Ontario Ministry of the Environment, 1981, 1982, 1983b
•NEMP, 1982

TABLE A-2

Prevailing Total Reduced Sulphur Levels ($\mu g/m^3$)
in the Golden Horseshoe

Ontario Criteria 1-Hour (H_2S) 30 $\mu g/m^3$)

Area	Annual Arithmetic Mean			Maximum 24-Hour Level*	Maximum 1-Hour Level*	Total No. of Criteria Exceedences*
	1982	1981	1980			1-Hour
Halton-Peel						
Oakville	2	1	2	45	130	123
Niagara Peninsula						
Cheapside	1	1	1	n/a**	12	0
Chippawa	8	17	17	n/a	605	2949
Nanticoke	<1	<1	<1	n/a	64	1
Walpole	<1	<1	<1	n/a	17	0

* Over entire collection period shown here.

** Not available.

Sources: •Ontario Ministry of the Environment, 1981, 1982, 1983b
•NEMP, 1982

TABLE A-3

Prevailing Total Suspended Particulate Levels ($\mu g/m^3$) in the Golden Horseshoe

Ontario Criteria	Annual	60 $\mu g/m^3$	Geometric Mean
	24-Hour	120 $\mu g/m^3$	

Area	Annual Geometric Mean			Maximum 24-Hour Level*	Total Number of Criteria Exceedences*
	1982	1981	1980		24-Hour
Halton/Peel					
Mississauga	72	88	105	294	70
North Etobicoke	61	60	58	179	15
Oakville	50	56	70	266	10
Niagara Peninsula					
Binbrook	39	35	43	94	0
Canboro	39	37	41	116	0
Canfield	41	38	46	101	0
Cheapside	37	37	53	125	1
Chippawa	67	96	125	196	5
Dogs Nest	32	33	39	92	0
Fisherville	40	40	46	123	1
Hagersville	42	40	43	256	2
Jarvis	46	43	56	301	5
Long Point	33	35	52	81	0
Nanticoke	37	37	42	134	1
Niagara Falls	54	60	68	125	2
Port Colborne	42	57	67	149	5
Port Dover	33	40	56	108	0
Rainham	33	33	36	153	1
Sandusk	34	40	40	87	0
Selkirk	35	37	50	88	0
Simcoe	22	32	40	121	1
St. Catharines	56	57	62	160	2
Thorold	92	-	-	368	11
Walpole	37	37	40	170	1
Welland	53	58	83	130	1

* Over entire collection period shown here.

Sources: · Ontario Ministry of the Environment 1981, 1982, 1983b
· NEMP, 1982

TABLE A-4

Prevailing Coefficient of Haze Levels (COH's per 1000 feet) in the Golden Horseshoe

Ontario Criteria		
	Annual	0.5 COH's/1000 ft.
	24-Hour	1.0 COH's/1000 ft.

Area	Annual Arithmetic Mean			Maximum 24-Hour Level*	Maximum 1-Hour Level*	Total No. of Criteria Exceedences*	
	1982	1981	1980			Annual	24-Hour
Halton-Peel							
Mississauga	.2	.3	n/a	1.3	2.6	0	n/a
North Etobicoke	.3	.3	.3	1.8	3.1	0	n/a
Oakville	.4	.4	.3	1.5	3.2	0	19
Niagara Peninsula							
Binbrook	.14	.16	.15	.5	n/a	0	0
Cheapside	.14	.15	.13	.5	n/a	0	0
Chippawa	.26	.26	.23	.8	n/a	0	0
Long Point	.15	.13	.12	.5	n/a	0	0
Niagara Falls	.23	.25	.22	1.0	n/a	0	0
Simcoe	.18	.19	.17	.8	n/a	0	0
St. Catharines	.29	.32	.31	1.4	n/a	0	2

* Over entire collection period shown here.

Sources: •Ontario Ministry of the Environment, 1981, 1982, 1983b
• NEMP, 1982

TABLE A-5

Prevailing Dustfall Levels (g/m^2/30 days)
in the Golden Horseshoe

Ontario Criteria	30 day - 7.0 g/m^2/30 days Annual - 4.5 g/m^2/30 days Avge.

Area	Annual Arithmetic Mean			Maximum 30-day Level
	1982	1981	1980	
Niagara Peninsula				
Chippawa	8.1	8.8	11.8	15.6
Greensville	9.5	10.5	10.2	15.3
Nanticoke	2.3	2.6	2.6	3.7
St. Catharines	10.3	8.1	10.3	19.8
Thorold	9.8	12.2	11.8	25.4
Welland	5.6	14.9	19.4	12.1

Note: Data for total number of exceedences was not available.

Sources: · Ontario Ministry of the Environment, 1981, 1982, 1983b
· NEMP, 1982

TABLE A-6

Prevailing Nitrogen Oxides Levels ($\mu g/m^3$)
in the Golden Horseshoe

Ontario Criteria NO_2	24-Hour	200 $\mu g/m^3$
	1-Hour	400 $\mu g/m^3$

Area		Annual Arithmetic Mean			Maximum 24-Hour Level*	Maximum 1-Hour Level*	Total No. of Exceedences*	
		1982	1981	1980			24-Hour	1-Hour
Halton Peel								
Mississauga	NO_2	50	55	55	120	220	0	0
	NO^2	30	35	30	320	1045		
	NO_x	95	110	95	590	1580		
N. Etobicoke	NO_2^x	40	45	35	140	275	0	0
	NO^2	35	35	25	425	980		
	NO_x	95	100	75	750	1680		
Oakville	NO_2^x	35	40	45	100	375	0	0
	NO^2	20	25	25	195	775		
	NO_x	65	80	80	375	1245		
Niagara Peninsula								
Binbrook	NO_2	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	NO^2	5	9	6	50	165		
	NO_x	n/a	34	28	n/a	n/a		
Cheapside	NO_2^x	14	20	16	100	200	0	0
	NO^2	1	1	3	40	220		
	NO_x	16	22	18	140	515		
Long Point	NO_2^x	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	NO^2	1	3	9	13	64		
	NO_x	n/a	20	28	n/a	n/a		

* Over entire collection period shown here.

Contd.

TABLE A-6 (Continued)

Prevailing Nitrogen Oxides Levels ($\mu g/m^3$) in the Golden Horseshoe

Ontario Criteria NO_2	24-Hour	200 $\mu g/m^3$
	1-Hour	400 $\mu g/m^3$

Area		Annual Arithmetic Mean			Maximum 24-Hour Level*	Maximum 1-Hour Level*	Total No. of Exceedences*	
		1982	1981	1980			24-Hour	1-Hour
Sandusk	NO_2	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	NO^2	5	10	12	180	26		
	NO_x	n/a	30	34	n/a	n/a		
Simcoe	NO_x	20	28	24	100	180	0	0
	NO^2	3	3	1	26	103		
	NO_x	24	34	26	100	255		
St.Catharines	NO_2^x	38	43	39	160	575	0	4
	NO^2	10	18	12	310	925		
	NO_x	53	71	59	630	1460		

* Over entire collection period shown here.

Sources: - Ontario Ministry of the Environment, 1981, 1982, 1983b
- NEMP, 1982

TABLE A-7

Prevailing Hydrocarbon Levels ($\mu g/m^3$) as CH_4 in the Golden Horseshoe

No Criteria

Area	Annual Arithmetic Mean			Maximum 24-Hour Level*	Maximum 1-Hour Level*
	1982	1981	1980		
Halton Peel					
Total Hydrocarbons					
North Etobicoke	1565	1505	1490	3020	8310
Oakville	1525	1620	1730	3160	13255
Niagara Peninsula					
Reactive Hydrocarbons					
Cheapside	440	460	250	1580	2200
Nanticoke	410	535	455	690	1100
Walpole	350	360	380	825	1170
Methane					
Cheapside	1000	1015	1000	1305	2745
Nanticoke	1060	1050	1015	1580	2335
Walpole	1065	960	935	1510	3915

* Over entire collection period shown here.

Sources: ·Ontario Ministry of the Environment, 1981, 1982, 1983b

·NEMP, 1982

TABLE A-8

Prevailing Carbon Monoxide Levels ($\mu g/m^3$)
in the Golden Horseshoe

Ontario Criteria	8-Hour	15700 $\mu g/m^3$
	1-Hour	36200 $\mu g/m^3$

Area	Annual Arithmetic Mean			Maximum 8-Hour Level*	Maximum 1-Hour Level*	Total No. of Criteria Exceedences*	
	1982	1981	1980			8-Hour	1-Hour
Halton-Peel							
Mississauga	1800	2885	2165	n/a	21630	n/a	0
N. Etobicoke	1320	1200	1320	n/a	15620	n/a	0
Oakville	1680	2765	1320	n/a	12020	n/a	0
Niagara Peninsula							
Binbrook	120	120	120	1200	2405	0	0
Long Point	120	240	120	1200	4810	0	0
St. Catharines	480	1200	720	9615	16825	0	0

* Over entire collection period shown here.

Sources: - Ontario Ministry of the Environment, 1981, 1982, 1983b
- NEMP, 1982

TABLE A-9

Prevailing Ozone Levels ($\mu g/m^3$)
in the Golden Horseshoe

Ontario Criteria 1 Hour 165 $\mu g/m^3$

Area	Annual Arithmetic Mean			Maximum 24-Hour Level*	Maximum 1-Hour Level*	Total No. of Criteria Exceedences*
	1982	1981	1980			1-Hour
Halton-Peel						
Mississauga	30	30	30	105	250	60
N. Etobicoke	30	30	30	125	265	102
Oakville	35	35	45	120	225	78
Niagara Peninsula						
Binbrook	50	50	50	n/a	185	9
Long Point	70	65	65	n/a	235	131
Simcoe	65	60	55	n/a	235	305
St. Catharines	45	40	45	n/a	285	126

* Over entire collection period shown here.

Sources: ·Ontario Ministry of the Environment, 1981, 1982, 1983b

·NEMP, 1982

APPENDIX B

GENERAL INFORMATION ON OTHER POLLUTANTS

APPENDIX B - GENERAL INFORMATION ON OTHER POLLUTANTS

B.1 TRACE ORGANICS

Hydrocarbons, as important primary pollutants, are emitted from both natural and anthropogenic sources. Volatile plant products and biogenic decomposition products are two major natural sources. Anthropogenic sources such as transportation vehicles, stationary combustion, industrial processing, and solvent evaporation account for a major portion of anthropogenic emissions. (Environment Canada, 1981(a); Environment Canada, 1981(b); Lamb et al., 1980; Tilton and Bruce, 1981). Methane is known to be the most abundant, but essentially inert, hydrocarbon in the atmosphere, and the importance of natural sources is well recognized. Consequently, this constituent is often excluded from measurements. There are few data with which to compare non-methane or reactive hydrocarbon concentrations in various geographical locations as it is usually monitored only in urban areas. From extensive measurements in one U.S. city, the classes of hydrocarbons, in decreasing order of importance, were found to be: alkanes (even when methane levels were excluded), aromatics, olefins, acetylene and alicyclics (Tilton and Bruce, 1981). However, the distribution by class for non-urban locations in Southern Ontario cannot be readily deduced from these data.

Alkanes are known to represent a large fraction of total hydrocarbons emitted by industry and, although less chemically reactive, are thought to ultimately generate as much ozone as olefins and aromatics (Lamb et al., 1980). High concentrations of ethylene have been reported in some urban areas. Automobile exhaust and incomplete combustion of municipal solid waste have been identified as significant sources (Stahl, 1969). Average urban concentrations of ethylene are shown in Table B-1 and levels reaching 800 ug/m^3 have been measured in the Los Angeles area (i.e., well above the Ontario air quality standard for ethylene). Such concentrations could be expected to affect plant growth and productivity (Lamb et al., 1980). Aliphatic aldehydes, such as

formaldehyde, are commonly found in both urban and rural airsheds as a result of primary emissions in vehicle exhaust and other incomplete combustion processes, as well as secondary products of photochemical reactions (Cleveland, 1977). Specific carboxylic acid derivatives, such as butyl and methyl acrylate, have been measured in several U.S. cities (Pellizari, 1977). Levels were generally below detection, except in Newark, N.J. where high levels were observed. No specific sources were identified. Several volatile chlorinated organic compounds, such as chloroform, trichloroethylene, tetrachloroethylene, etc., have been determined in U.S. cities where sampling was conducted near sources that handled, stored or produced chlorinated hydrocarbons (Pellizari, 1977; Harkov et al., 1980). However, the ubiquitous nature and persistence of such components is evident by their occurrence in more remote areas (Singh et al., 1977). Other nitrogen-containing organic compounds (nitrosamines for example) have been determined in urban atmospheres (Shapley, 1976) and, very recently, rural concentrations of acetonitrile have been measured (Becker and Ionescu, 1982). Both vehicle exhaust and grass fires are known to emit nitriles. The major aromatic vapours, that are widely distributed in air and of anthropogenic origin, are benzene, toluene and xylenes (Tilton and Bruce, 1981).

It can be seen from data shown in Table B-1, that both urban and non-urban concentration ranges of individual volatile hydrocarbon constituents that have been reported in various locations are generally well below regulated limits in Ontario (Table B-2). It has been concluded in a recent review that "while <u>specific</u> vapour-phase hydrocarbon compounds can be of concern to public health (e.g., benzene) and welfare (e.g., ethylene), as a class, this <u>group</u> of compounds cannot be considered a hazard to human health or welfare at or even well above those concentrations observed in the ambient air" (Tilton and Bruce, 1981).

Higher molecular weight species (> C7) are usually considered to be associated with particulate matter due to condensation processes. However, reliable sampling methods for the fraction of organic vapour and particles are lacking. Characterization of ambient aerosols generally indicates large fractions of extractable organic material which can be of either primary or secondary origin. Detailed characterization has been done, for example in Los Angeles and New Jersey (Cronn et al., 1977; Lioy and Daisey, 1983). Total alkanes and alkyl benzenes represented a significant organic fraction of aerosols in Los Angeles attributable directly to motor vehicle exhaust. Other primary organic aerosol components were alkenes, napthalene and alkyl piperidines, along with a series of secondary organic components considered to be photochemical products of olefin precursors (Cronn et al., 1977). Other lesser components, that may be particularly toxic, have been studied extensively, including PAH compounds, dicarboxylic acids, pesticides and numerous other constituents, and ambient data are tabulated in several reports (Great Lakes Sciences Advisory Board, 1980; Cautreels et al., 1977; Grosjean et al., 1978; Ontario Ministry of the Environment, 1979). Some of the PAH compounds which are released from most combustion processes are of widespread occurrence and continue to receive extensive investigation. It is well recognized that the potential hazard of particulate matter, in general, should be judged on the distribution of particle size and chemical composition (Lamb et al., 1980). An extensive, long-term, data base on trace organics in fine particles has yet to be generated.

B.2 TRACE METALS

Measurements of trace metals, usually associated with particulate matter, have been reported for a number of locations. Representative data are summarized in Table B-1. The principal anthropogenic sources of trace metals are coal fired generating stations, primary and secondary metal

production/processing, oil-fired combustion sources, municipal incineration, vehicle exhaust and re-entrained road dust. The major natural source relevant to Ontario is resuspended crustal material, while small contributions could occur due to vegetative burning and biogenic emissions. Trace elements for which monitoring data are available, that are considered to be relevant to industrial waste treatment and disposal, are: arsenic, antimony, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc (Bonner et al., 1981; Angiola and Eisen, 1982; Office of Technology Assessment, 1983). On the basis of several review articles, it is known that essentially all trace elements are enriched in urban aerosols, when compared to crustal material, and that combustion product particle sizes are generally smaller than resuspended crustal dust (UTS/ORF, 1982). It can be seen from the tabulated data that levels of elements measured in urban areas are typically several orders of magnitude greater than in remote areas. Data that have been generated in eight monitoring stations of the Nanticoke Environmental Monitoring Programme (NEMP, 1982) are of particular relevance to the rural Golden Horseshoe candidate areas and are considered to provide the most appropriate information with respect to background levels of specific trace metals. Elemental mercury, that exists primarily as vapour, has been measured at both a suburban station in Mississauga and a more remote station (Barton et al, 1981). Alkyl mercury vapour was found to be essentially non-detectable in these studies.

Apart from a specific exceedence of the 24-hour nickel criterion at one MOE station, and potential exceedences of lead near heavy traffic areas, as found in some cities, levels of trace metals in both rural and urban areas are evidently well below Ontario short-term standards and longer-term criteria. Most MOE stations in the province (> 85%) currently meet the 24-hour lead criterion, and ambient lead levels have

decreased in recent years as a result of reduced vehicle lead emissions, and improved controls of lead processing plants (Heidorn, 1981).

B.3 MACROELEMENTS AND MAJOR NUTRIENTS

Typical background levels of macroelements such as aluminum, calcium, magnesium, silica, etc. are summarized in Table B-1. Ambient levels of these crustal constituents are generally attributable to local wind-blown soil, re-entrained road dust and fugitive dust producing operations. Fly ash, emitted from combustion processes, also contains a significant fraction of these constituents. This ubiquitous occurrence of these constituents sometimes presents difficulties in attempting to distinguish specific sources that can contribute to airborne particulate matter (Cooper and Watson, 1980). Components such as sulphate and nitrate are usually a consequence of several types of sources. Direct emissions of particulate sulphate or sulphuric acid from several industrial and combustion processes can occur (ORF, 1982), or aerosol sulphate can be formed from atmospheric oxidation of SO_2. Nitrate is usually considered a secondary aerosol constitutent, but can also result from windblown fertilized soils. It can be expected that long-range transport of these constituents or their precursors contributes substantially to the observed levels of particulate matter in Southern Ontario.

B.4 ACID GASES

Existing airborne chloride and fluoride concentrations are of particular relevance to emissions from incinerators treating halogen-containing waste. For instance, emissions of both hydrochloric acid and hydrofluoric acid can be anticipated from the proposed OWMC facility (Bonner, et al., 1981). Similarly, other industrial processes and stationary fuel combustion sources are reported to emit fluoride, with a major fraction being emitted as gaseous fluoride (Rose and Marier, 1977). Particulate chloride and fluoride have been monitored by high-volume sampling in the Nanticoke area (NEMP, 1982) but,

unfortunately, little data exist on background concentrations of the gaseous fractions. The method of monitoring long-term average deposition rates with passive fluoride candles continues to be used extensively, but such methods fail to distinguish between the vapour and particulate fractions. Thus, only qualitative assessments of the potential for plant damage can be made using this method. Similarly, difficulties are encountered in converting measured deposition rates to actual concentrations.

Fluoridation rates are monitored by MOE at several stations in the Port Maitland and Nanticoke areas and deposition rates have been found to substantially exceed the summer air quality criterion of 40 ug/100 cm^2/30 days at several stations in the Port Maitland area during 1982. Rates at most Nanticoke stations were less than one-half this value. It should be noted that Canadian investigators have suggested that "the average gaseous fluoride level in ambient air should be below 0.4 ug/m^3 and might have to be as low as 0.2 ug/m^3 in order to protect forest species (Rose and Marier, 1977, p. 38). The current 30-day ambient air quality criterion for gaseous fluorides during the growing season is 0.34 ug/m^3.

TABLE B-1

Summary of Ambient Air Concentrations of Trace Organic and Inorganic Constituents in Various Airsheds

General Contaminant Class[a]	Ambient Concentration (ng/m^3)[b]						Comments
	Urban		Rural		Remote		
	Average	Range	Average	Range	Average	Range	
1. Aliphatic and Cyclic Hydrocarbons							
Acetylene	10,700[2]	5,300-106,000[1]		500-5,800[1]		0-400[1]	Various U.S. locations[1].
Ethylene	14,300[2]	40,000-120,000[3]					Sydney, Australia[2].
Hexane	7,400[2]	8,400-260,000[1]					California Urban Areas[3].
2. Organics with Carbon-Oxygen Bonds							
a) Aldehydes, Ketones							
Formaldehyde		8,600- 19,600[4]				120-3,100[5]	U.S. cities[4]. Background[5].
Methyl Ethyl Ketone	ND[6]						New Jersey cities[6].
b) Carboxylic Acids and Derivatives							
Butyl Acrylate		ND-17,000[7]					New Jersey cities[7].
Methyl Acrylate		ND-4,500,000[7]					
3. Organics with Carbon-Nitrogen Bonds							
a) Amines							
Acetonitrile				3,700-10,400[8]			Rural areas in Western Europe[8]
b) Nitrosamines							
2,4-Dimethyl Nitrosamine		20-100[9]					Various U.S. cities[9].
5. PCB's and Organohalogen Pesticides							
a) Halogenated Aromatic Compounds							
PCB's							
Polychlorinated Biphenyls	5-10[10]	0.5-30[10]		0.1-2[10]		0.02-0.5[10]	Worldwide measurements[10].
b) Organohalogen Pesticides							
Aldrin	8[10]			0.0-1[10]			
Dieldrin	8[10]	0.5-10[10]		0.01-0.1[10]			
Chlordane		0.1-0.5[10]		0.01-0.05[10]			
2,4-D				4[10]			N. America[10].
DDT		0.1-1[10]		0.01-0.05[10]			Worldwide measurements[10].
Endrin				2.3-58.5[10]			N. America[10].
Heptachlor		2-20[10]		1-5[10]			N. America[10].

Contd.

TABLE B-1 (Continued)(ii)

Summary of Ambient Air Concentrations of Trace Organic and Inorganic Constituents in Various Airsheds

General Contaminant Class[a]	Ambient Concentration (ng/m^3)[b]						Comments
	Urban		Rural		Remote		
	Average	Range	Average	Range	Average	Range	
Lindane + αBHC		2-10[10]		1-4[10]			Worldwide measurements[10]
Toxaphene		0.02-10[10]		0.02-2[10]			
6. Other Halogenated Organics							
a) Low Molecular Wt., Volatile							
Carbon Tetrachloride					720[11]		Continental U.S. Background[11]
Chloroform		2,000-37,000[7]			80[11]		
1,2-Dichloroethane	32[6]	ND-64,500[7]					New Jersey cities[7].
Difluoro dichloromethane					1000[11]		Continental U.S. Background[11]
Hexachloroethane					70[12]		
Methyl Bromide					20[11]		
Methyl Chloride					1470[11]		
Methylene Chloride					150[11]		
Tetrachloromethane	360[6]	29,000[6] max.					New Jersey cities[6].
Tetrachloroethylene	6,400[6]	4,000-6,800[13]			210[11]		Range of averages in various cities[13].
Trichloroethane	200[6]	Trace-13,000[7]			540[11]		Continental U.S. Background[11].
Trichloroethylene	2,700[6]	ND-1,200[7]		100-1,000[10]	80[11]		Alaska[10]
Trifluorotrichloromethane					150[11]		Continental U.S. Background[11].
Vinyl Chloride	130[6]	ND-120,000[7]					New Jersey cities[7].
b) Halogenated Aromatic Compounds							
Chlorobenzene	2,500[6]	ND-20,000[7]					New Jersey cities[7].
							New Jersey cities[6].
Hexachlorobenzene				0.1-0.3[10]			Worldwide measurements[10]
Trichlorobenzene		ND-867[7]					New Jersey cities[7].
c) Halogenated Phenolic Compounds							
Pentachlorophenol		0.25-7.28[14]					European cities[14].
7. Polynuclear Aromatic Hydrocarbons (PAH's) and Derivatives							
Benzo(a)pyrene		0.11-3.50[15]					Major cities in Ontario[15]
Chlorinated Naphthalenes		10-25[10]					Worldwide measurements[10].

Contd.

TABLE B-1 (Continued)(iii)

Summary of Ambient Air Concentrations of Trace Organic and Inorganic Constituents in Various Airsheds

General Contaminant Class[a]	Ambient Concentration (ng/m^3)[b]						Comments
	Urban		Rural		Remote		
	Average	Range	Average	Range	Average	Range	
Fluoranthene	4[15]	0.3-93[15]					Average U.S. cities[15].
Naphthalene				70-1,300[16]			Sweden[16].
9. Organo-phosphorus Compounds							
Malathion			2[10]				Non-urban N. America[10]
Methyl Parathion				5.4-129[10]			
Parathion				465[10]			
11. Other Substituted Aromatics							
a) Benzene, Substituted Benzene Hydrocarbons							
Benzene	41,000[18]	600-30,000[10]		700-7,000[17]			Boulder, Col.[17].
							Downtown Toronto[18].
							Worldwide measurements[10].
Dibutyl Phthalate		ND-11[19]		0.5-5.0[10]			New York[19].
							Worldwide measurements[10].
Diethyl Hexyl Phthalate		ND-28.6[19]		0.5-5.0[10]			
Ethyl Benzene		6,500-38,000[13]					Various cities[13]
Isopropyl Benzene		1,900-96,000[13]					
Toluene	113,000[18]	600-50,000[10]		2,500-12,000[16]			Downtown Toronto[18].
							Worldwide measurements[10].
							Near Swedish city[16].
Trimethyl Benzenes (e.g. 1,2,4-Trimethyl Benzene)		4,400-44,000[13]					Various cities[13].
Xylenes (e.g. M-+p-xylenes)		2,200-132,000[13]					
b) Aromatic Nitrogen Compounds							
Nitrobenzenes		ND-126[7]					New Jersey cities[7].
12. Organo-metallics							
Mercury (Alkyl)	<3[20]		<3[20]				Mississauga, Dorest, Ont.[20].
15. Volatile Metals							
Arsenic		2-2,320[21]		0.2-329[21]		0.007-1.9[21]	Worldwide measurements[10].

Contd.

TABLE B-1 (Continued)(iv)

Summary of Ambient Air Concentrations of Trace Organic and Inorganic Constituents in Various Airsheds

General Contaminant Class[a]	Ambient Concentration (ng/m^3)[b]						Comments
	Urban		Rural		Remote		
	Average	Range	Average	Range	Average	Range	
Mercury	8[20]	2-80[20]	3[20]	2-6[20]		<0.5-4[22]	Mississauga, Ontario[20]. Dorset, Ontario[20]. California Coast[22].
16. Heavy Metals							
Antimony		0.5-470[21]		1-146[21]		0.0008-1.19[21]	Worldwide measurements[21].
Cadmium		0.17-7,000[21]	(6)[23]	0.4-1,000[21] (1.0-160)[23]		0.003-1.09[21]	NEMP Stations[23].
Chromium		<0.3-227[21]	(7)[23]	3-44[21] (N.D.-36)[23]		0.0053-11.2[21]	Range of all NEMP Stations[23].
Cobalt		0.2-183[21]		0.6-6.2[21]		0.00049-1.9[21]	Range of all NEMP Stations[23].
Copper		< 3-5,140[21]	(52)[23]	3-280[21] (N.D.-650)[23]		0.029-10[21]	Worldwide measurements[21].
Iron		130-20,600[21]	(485)[23]	200-14,500[21] (4-3,950)[23]		0.63-4,160[21]	
Lead		14,000-54,000[25]	(80)[23]	30-800[24] (N.D.-304)[23]			Non-urban U.S.[24].
Manganese		9-850[21]	(20)[23]	(6.5-99.1)[21] (N.D.-143)[23]		0.01-79[21]	Worldwide measurements[21].
Nickel		0.3-1,400[21]	(12)[23]	0.2-68[21] (N.D.-140)[23]		<0.01-0.57[21]	
Vanadium		0.16-1,460[21]	(8)[23]	2-97[21] (1-41)[23]		0.0015-14[21]	
Zinc		N.D.-8,330[21]	(62)[23]	11-4,620[21] (4-543)[23]		0.03-460[21]	
17. Major Nutrients							
Nitrate		1,500-11,500[26]	(3,580)[23]	(50-10,800)[23]			Range of monthly means for measurements in Toronto, Oakville, St. Catharines[26].
18. Macroelements							
Aluminum			(694)[23]	(30-10,000)[23]			NEMP Stations[23].

Contd.

TABLE B-1 (Continued)(v)

Summary of Ambient Air Concentrations of Trace Organic and Inorganic Constituents in Various Airsheds

General Contaminant Class[a]	Ambient Concentration (ng/m^3)[b]						Comments
	Urban		Rural		Remote		
	Average	Range	Average	Range	Average	Range	
Calcium			(1,120)[23]	(15,-18,070)[23]			NEMP Stations[23]. Particulate fraction in various cities in Japan[28].
Chloride		<500-15,500[28]	(141)[23]	(1-2,916)[23]			
Fluoride		10-13,200[29,30]	(35)[23]	(1-2,500)[23]		<50[27]	Total fluoride concentrations at various distances from phosphate rock processing operations[29,30].
Magnesium			(306)[23]	(5-3,790)[23]			Natural Background[27].
Silica			(3,400)[23]	(2-33,400)[23]			
Sulphate		2,400-18,000[26]	(6,600)[23]	(1,100-20,900)[23]			Range of monthly means for measurements in Toronto, Hamilton, Oakville and St. Catharines[26].
19. Acid Gases							
Hydrogen Chloride		<500-12,100[28]					Vapour Cl fraction in various Japanese cities[28].
Hydrogen Fluoride		<1,000[31]		N.D.[31]			

a) Contaminant class arrangements were defined in a previous report (IEC/Beak, ORF, 1983).

b) Concentrations shown are representative of various measurement averaging periods (i.e. grab samples or longer term cumulative samples). Values bracketed are daily NEMP monitoring data averaged for the years 1979 and 1980.

Contd.

TABLE B-1 (Continued)(vi)

Summary of Ambient Air Concentrations of Trace Organic and Inorganic Constituents in Various Airsheds

Table References

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30. Sidhu (1979)
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TABLE B-2

Ontario Air Quality Standards and Guidelines In Conjunction with General Chemical Categories

Contaminant	Maximum Permitted 1/2-Hour Point-of-Impingement Concentration ($\mu g/m^3$)			
	Standard[a]	Tentative Standard[b]	Guideline[b]	Provisional Guideline[b]
TRACE ORGANICS				
Aliphatic and Cyclic Hydrocarbons				
Acetylene	56,000			
Cyclohexane			300,000	
Ethylene		160		
Hexane			35,000	
Organics with Carbon-Oxygen Bonds				
a) Ethers				
Dimethyl Ether			2,100	
b) Alcohols				
Ethanol			19,000	
2-Ethyl Hexanol			600	
Furfuryl Alcohol	3,000			
Propanol			48,000	
c) Glycols, Epoxides				
Ethylene Oxide	28,500			
Methyl Ethyl Ketone Peroxides			250	
Propylene Oxide	78,000			
d) Aldehydes, Ketones				
Acetone	48,000			
Formaldehyde	65			
Methyl Ethyl Ketone	31,000			
d) Carboxylic Acids & Derivatives				
Acetic Acid	2,500			
Butyl Acrylate			100	
Butyl Stearate			100	

TABLE B-2 (ii)

Contaminant	Maximum Permitted 1/2-Hour Point-of-Impingement Concentration ($\mu g/m^3$)			
	Standard[a]	Tentative Standard[b]	Guideline[b]	Provisional Guideline[b]
2-Ethoxyethyl Acetate			100	
Ethyl Acetate	19,000			
Ethyl Acrylate	4.5			
Formic Acid	1,500			
Maleic Acid			100	
Methacrylic Acid			2,000	
Methyl Acrylate	4.0			
Methyl Methacrylate	860			
Organics with Carbon-Nitrogen Bonds				
a) Nitriles				
Acrylamide	45			
Acrylonitrile	2,200			
Nitrilotriacetic Acid	100			
b) Amines				
4,4-Methylene-bis-2-chloroaniline			30	
Methylene Dianiline			30	
Organics with Carbon-Sulphur Bonds				
a) Thiols, Sulphides, Disulphides				
Carbon Disulphide	330			
Dimethyl Disulphide	40			
Dimethyl Sulphide	30			
Mercaptans	20			
Tetramethylthiuram Disulphide			30	
PCB's and Organohalogen Pesticides				
a) Halogenated Aromatic Compounds				
Polychlorinated Biphenyls			.45	

TABLE B-2 (iii)

Contaminant	Maximum Permitted 1/2-Hour Point-of-Impingement Concentration ($\mu g/m^3$)			
	Standard[a]	Tentative Standard[b]	Guideline[b]	Provisional Guideline[b]
b) Organohalogen Pesticides				
Methoxychlor			100	
Other Halogenated Organics				
a) Low Molecular Wt., Volatile				
Carbon Tetrachloride	20,000			
Chloroform			1,500	
1,1-Dichloroethylene	26,000			
Dichloropropanes	2,400			
Difluoro dichloromethane			1,500,000	
Methyl Bromide	12,000			
Methyl Chloride			20,000	
Methylene Chloride	100,000			
Phosgene	130			
Polychloroprene			100	
Tetrachloroethylene			10,000	
Trichloroethane	350,000			
Trichloroethylene	85,000			
Trifluorotrichloroethane	2,400,000			
Vinyl Chloride			560	
b) High Molecular Wt., Aromatic				
Hexachlorobenzene			100	
Pentachlorophenol	90		60	
α-Napthol			100	
Heterocyclic Organics				
a) Nitrogen Compounds				
Bromacil			30	
b) Oxygen Compounds				
Tetrahydrofuran	93,000			

TABLE B-2 (iv)

Contaminant	Maximum Permitted 1/2-Hour Point-of-Impingement Concentration ($\mu g/m^3$)			
	Standard[a]	Tentative Standard[b]	Guideline[b]	Provisional Guideline[b]
Organo-phosphorus Compounds				
Diazinon			9	
Malathion			100	
Dioxins				
Dioxin				.00045
Other Substituted Aromatics				
a) Benzene, Substituted Benzene Hydrocarbons				
Benzene	10,000			
Biphenyl			60	
Dioctyl Phthalate	100			
Di-2-Octyl Phthalate	100			
Ethyl Benzene	4,000			
Mercaptobenzothiazyl Disulphide			100	
Methylene di-p-phenylene Isocyanate		3		
Phthalic Anhdride	100			
Styrene	400			
Toluene	2,000			
Toluene Diisocyanate	1			
Trimethyl Benzenes (e.g. 1,2,4-Trimethylbenzene)			100	
Xylenes (e.g. m-+p-xylenes	2,300			
b) Phenols				
Cresols	230			
Phenol	100			

TABLE B-2 (v)

Contaminant	Maximum Permitted 1/2-Hour Point-of-Impingement Concentration ($\mu g/m^3$)			
	Standard[a]	Tentative[b] Standard	Guideline[b]	Provisional[b] Guideline
Organo-metallics				
Dibutyltin Dilaurate			100	
Mercury (Alkyl)	1.5			
Nickel Carbonyl	1.5			
Tripropyltin Methacrylate			3	
TRACE INORGANICS				
pH-Volatile Inorganics				
Ammonia	3,600			
Cyanide (Hydrogen Cyanide)	1,150			
Decaborane	50			
Diborane	20			
Hydrogen Sulphide	30			
Lithium Hydrides	75			
Pentaborane	3			
Reactive Inorganics				
Bromine	70			
Chlorine	300			
Chlorine Dioxide	85			
Magnesium Oxide	100			
Phosphorus Pentachloride			30	
TRACE METALS				
Volatile Metals				
Arsenic	75			
Arsine	15*			
Mercury	10			
Selenium	5		20	

* Under Review

TABLE B-2 (vi)

Contaminant	Maximum Permitted 1/2-Hour Point-of-Impingement Concentration ($\mu g/m^3$)			
	Standard[a]	Tentative[b] Standard	Guideline[b]	Provisional[b] Guideline
Heavy Metals				
Antimony	75			
Barium			30	
Beryllium	.03			
Boron	100			
Cadmium	5			
Chromium	30			5
Copper	100			
Lead	10			
Lithium	60			
Manganese	100			
Nickel	5			
Silver	3			
Tellurium	30			
Tin	30			
Titanium	100			
Vanadium	5			
Zinc	100			
ACID GASES				
Hydrogen Chloride	100			
Hydrogen Fluoride	4.3			
Nitric Acid	100			
Sulphuric Acid	100			
OTHER				
Sulphur Dioxide	830			
Nitrogen Oxides (as NO_2)	500			
Ozone	200			

TABLE B-2 (vii)

Contaminant	Maximum Permitted 1/2-Hour Point-of-Impingement Concentration ($\mu g/m^3$)			
	Standard[a]	Tentative[b] Standard	Guideline[b]	Provisional[b] Guideline
Carbon Monoxide	6,000			
Total Suspended Particulates	100			
Asbestos (fibres/cc)			5	
Talc (fibrous)			5	

(a) M.O.E. Regulation 308 (Ontario Ministry of the Environment, 1982).
(b) List of tentative standards, guidelines and provisional guidelines for air contaminants (Ontario Ministry of the Environment, 1983).

APPENDIX C

Initial Comparative Evaluation
Factor Sheets

OWMC Phase 3 - Factors for Identification of Candidate Sites
(Initial Comparative Evaluation)

FACTOR GROUPING:	FACTOR:
Physical Environment - Atmospheric	Existing Air Quality

FACILITY COMPONENTS AFFECTED: Incinerator

DEFINITION OF FACTOR:

Existing ambient air quality on an annual basis is defined with the aid of a composite air quality index for each site by summing the SO_2, NO_x, TSP and THC levels extrapolated from contour maps.

RATIONALE/SIGNIFICANCE:

Comparison of the values of this parameter allows the sites to be categorized relative to one another, and subsequently ranked as having low, moderate or high relative pollutant levels.

SOURCES OF INFORMATION:

Ambient air quality concentration isopleths for the candidate areas were generated using the USEPA's ISC model and an inventory of emission sources for Southern Ontario.

Results were verified at some locations by comparison with monitoring data.

INTERPRETATION/METHODOLOGY:

Existing air quality levels were generally considered to be a constraint only if pollutant levels were indicated to be relatively high.

FACTOR GROUPING:
Physical Environment - Atmospheric

FACTOR:
Existing Air Quality

CRITERIA/INDICATORS:

The existance of a combined air pollution index greater than approximately 75% of the maximum value warranted the classification of the site as having a constraint.

COMMENTS/ASSUMPTIONS/LIMITATIONS:

- The air quality modelling results are subject to a certain degree of error, although they correlated well with available monitoring data.

- Air quality levels were not considered relative to air quality criteria.

- The air quality index used in this assessment is for comparison purposes only - its numerical value has no physical significance.

OWMC Phase 3 - Factors for Identification of Candidate Sites
(Initial Comparative Evaluation)

FACTOR GROUPING:
Physical Environment - Atmospheric

FACTOR:
Topography

FACILITY COMPONENTS AFFECTED:
Incinerator

DEFINITION OF FACTOR:
Topographical features on a local scale having the potential to limit the dispersion of pollutants under some meteorological and emission conditions, for example, significant river valleys, elevated receptors.

RATIONALE/SIGNIFICANCE:
Higher pollutant concentrations can potentially be experienced if emissions are trapped or constrained by a feature or if direct impingement upon a topographical (elevated) receptor occurs.

SOURCE OF INFORMATION:
Visual inspection.
Topographical maps (1:10,000)

INTERPRETATION/METHODOLOGY:
Constraint was assessed according to topographical feature proximity and potential severity of effects on air dispersion.

FACTOR GROUPING:
Physical Environment - Atmospheric

FACTOR:
Topography

CRITERIA/INDICATORS:
Physical features on or near the sites greater than approximately 10 m in height or depth were considered.

COMMENTS/ASSUMPTIONS/LIMITATIONS:

- The 10 m criterion was selected to provide an indication of topographic features likely to be significant. The actual effects of these features will depend on final plant design.

OWMC Phase 3 - Factors for Identification of Candidate Sites
(Initial Comparative Evaluation)

FACTOR GROUPING: Physical Environment - Atmospheric

FACTOR: Receptors

FACILITY COMPONENTS AFFECTED: Incinerator

DEFINITION OF FACTOR:
Any potential local receptor of emissions from the incinerator stack, with special emphasis on populated areas.

RATIONALE/SIGNIFICANCE:
It is generally considered more desirable, from the point of view of potential exposure to emissions, to locate a facility as far away from receptors (especially sensitive receptors) as possible.

SOURCES OF INFORMATION:
Visual inspection.
Topographical maps (1:10,000)

INTERPRETATION/METHODOLOGY:
Proximity to populated centres constituted a constraint relative to the size of and distance to the potentially exposed population.

FACTOR GROUPING:
Physical Environment - Atmospheric

FACTOR:
Receptors

CRITERIA/INDICATORS:

All settlements and dwellings were taken into account. A relative assessment resulted in sites located closest to the largest populations having a high potential constraint and the more remote rural areas classed as having no constraint.

COMMENTS/ASSUMPTIONS/LIMITATIONS:

- Actual population numbers were not considered in this initial assessment. More refined population estimates were made by the socio-economic consultant (Institute of Environmental Research, 1984).